

Appendix G – Glossary and Explanation of Key Terms

The standards use a variety of terms relating to building attributes, features and devices; building energy conservation; energy efficiency and the calculations required for submittal to the local enforcement agency. The purpose of this chapter is to define and explain relevant terms in the context of the standards for low-rise residential buildings.

For certain topics, the text provides a cross reference to other parts of the manual, as well as to other Energy Commission publications and notices. Any direct quote from another source "is indicated with quotation marks like this." References to the standard are shown in brackets with the § symbol.

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Alternative Component Packages	o Computer Method (C-2R)	Decorative Gas Appliance
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ASHRAE Handbook of Fundamentals		Dual-Glazed Greenhouse Windows
ASME		East-Facing
ASTM		EER (Energy Efficiency Ratio)
Back		Efficacy
Btu/hr (Btu/h)		Electric Resistance Heating
Building Envelope		Enclosed Space
Building Location Data		Energy Budget
Building Types		Energy Efficiency Standards
Climate Zone		Energy Factor (EF)
Coefficient of Performance, Cooling (COP)	Conditioned Floor Area (CFA)	Energy Obtained From Depletable Sources
	Conditioned Footprint Area	

Energy Obtained From Nondepletable Sources	o Duct Losses	Proposed Design
Enforcing Agency	o Efficiency Conversions	Radiant Barriers
Evaporative Cooler	o Electric Resistance Heating	Raised Floor
Exceptional Method	o Gas Furnaces, Room Heaters and Boilers	Readily Accessible
Exfiltration	o Heat Pump	Rear
Exterior Door	o Packaged Air Conditioner	Recovered Energy
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Exterior Partition	o Wood Heater	Refrigerant Charge
Exterior Roof/Ceiling	o Zonal Control	Repair
Exterior Wall	High-Rise Residential	Right
Exterior Wall Area	HSPF (Heating Seasonal Performance Factor)	Roof
Fenestration Area (Glazing Area)	HVAC	R-Value (Thermal Resistance)
Fenestration Product	Hydronic Space Heating	o Default R-values/U-factors in Appendix H
Fireplace	Indirectly Conditioned Space	o How to Complete Form 3r
Floor Area	Infiltration	o Parallel Path Method
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Fossil Fuels	Insulation	o Simplified Masonry U-factor Calculation in Appendix I
Framing Effects	Insulation R-Value	SEER (Seasonal Energy Efficiency Ratio)
Front	Interior Partition	Service Water Heating
Gas Heating System	Knee Wall	Shading
Gas Log	Left	Shading Coefficient (SC)
General Lighting	Lighting	Solar Heat Gain Coefficient (SHGC)
Geothermal Heat Pump	Liquid Line	o External Shading Devices
Glazing	Low-Rise Residential	o Instructions for Form S
Ground Floor Area	Lumens/Watt	o Overhangs
Ground Source Heat Pump	Manufactured Device	o Shading by Adjacent Structures or Terrain or other Permanent Obstructions
Habitable Story	Mixed Occupancy	
Heat Capacity (HC)	Multi-Family	
Heat Pump	NFRC	
Heating, Ventilating and Air Conditioning (HVAC)	North-Facing	
o Air Conditioners	Outside Air	Side Fins
o Certification		
o Combined Hydronic Space and Water Heating		

Single Family Attached	Standards	Unconditioned Space
Single Family Building	Standby Loss	Unit Interior Mass
Skylight	Straw Bales	Capacity (UIMC)
Slab-on-Grade	Subordinate Occupancy	Vapor Barrier
Solar Heat Gain	Suction Line	Ventilation Air
Coefficient (SHGC)	System	Weatherstripping
Source Energy	Task Oriented Lighting	Weighted Averaging
South-Facing	Thermal Mass	West-Facing
Space Conditioning	Thermostatic Expansion	Wood Heater
System	Valves (TXV)	Zonal Control
Stairs	Title 24	Zone, Space
Standard Design	U-factor	Conditioning

Explanation of Terms

ACCA Air-Conditioning Contractors of America.

Accessible “[H]aving access thereto, but which first may require removal or opening of access panels, doors, or similar obstructions.” [§101] (see also *Readily Accessible*).

Additions An addition is an extension or increase in the conditioned floor area and volume of a building. This includes converting an existing unconditioned space to a conditioned space, such as remodeling a basement, garage or attic. The standards require energy compliance analysis and documentation for all additions that increase the conditioned space and volume of the building. Chapter 7 includes detailed discussion of energy compliance for additions. See also *Alteration*, *Building Type*, *Conditioned Space* and *Conditioned Floor Area*.

AFUE (Annual Fuel Utilization Efficiency) The ratio of annual output energy to annual input energy, which includes any non-heating pilot input loss and, for gas- or oil-fired furnaces or boilers, does not include electric energy. This is determined using the applicable test method in the Appliance Efficiency Regulations or §112 of the standards. AFUE is similar to the thermal efficiency for water heaters in that it does not include energy consumption from electric auxiliaries.

The *Appliance Efficiency Regulations* require that the AFUE of all new central furnaces manufactured on or after January 1, 1992 be at least 78 percent for equipment with output capacity less than 225,000 Btu/hr. Central furnaces with outputs greater than or equal to 225,000 Btu/hr are rated according to their Steady State (or Thermal) Efficiency. Other space heating equipment manufactured on or after January 1, 1994 has the following AFUE requirements:

Appliance	Capacity	AFUE
Furnace	All Sizes	78%
Gas Steam Boilers	Less than 300,000 Btu/h	75%
Gas Steam Boilers	300,000 Btu/h or larger	80%
Other Boilers	All sizes	80%

Gas space heaters manufactured on or after January 1, 1990 shall be certified to have AFUE values greater than or equal to those listed in Table G-1 below:

Table G-1: Non-Ducted, Non-Central Gas-Fired Heating Equipment

Type	Size	AFUE
Wall Furnace (fan type)	up to 42,000 Btu/hour	73%
	over 42,000 Btu/hour	74%
Wall Furnace (gravity type)	up to 10,000 Btu/hour	59%
	over 10,000 Btu/hour up to 12,000 Btu/hour	60%
	over 12,000 Btu/hour up to 15,000 Btu/hour	61%
	over 15,000 Btu/hour up to 19,000 Btu/hour	62%
	over 19,000 Btu/hour up to 27,000 Btu/hour	63%
	over 27,000 Btu/hour up to 46,000 Btu/hour	64%
	over 46,000 Btu/hour	65%
Floor Furnace	up to 37,000 Btu/hour	56%
	over 37,000 Btu/hour	57%
Room Furnace	up to 18,000 Btu/hour	57%
	over 18,000 Btu/hour up to 20,000 Btu/hour	58%
	over 20,000 Btu/hour up to 27,000 Btu/hour	63%
	over 27,000 Btu/hour up to 46,000 Btu/hour	64%
	over 46,000 Btu/hour	65%

The AFUE of mobile home furnaces manufactured on or after September 1, 1990 shall be certified not to be less than 75 percent.

See *Heating, Ventilating and Air Conditioning*.

Air Conditioner

Central air conditioners with output less than 65,000 Btu/h (5.4 tons) are rated according to their Seasonal Energy Efficiency Ratio (SEER). The SEER is the ratio of the total cooling output of a central air conditioner for the cooling season divided by the total electric energy input in watt-hours for the same period. The SEER accounts for fan electricity as well as the cycling of the compressor.

For split system air conditioners, the SEER depends on both the condensing unit (compressor) and the type of fan and coil (indoor unit). Equipment manufacturers typically list the SEER for just a few compressor-indoor unit combinations. If the type of indoor unit is not known, the SEER used for compliance should be for the most common indoor unit, e.g. the largest selling indoor unit on the national market.

The test procedures for SEER assume that the system has the correct refrigerant charge and that airflow across the evaporator coils is properly set. The efficiency of the unit will suffer if these conditions do exist. The standards require that split systems be field verified to have the correct charge and airflow. Alternatively, a thermostatic expansion valve (TXV) can be installed, which mitigates the impact of having improper charge and/or airflow.

Another efficiency measure for air conditioners is the EER, but this measure is for peak conditions. The SEER is generally higher than the EER; since it is based on seasonal performance and the EER is for less favorable weather conditions (95 °F outdoor temperature). Central air conditioners with a capacity of 65,000 Btu/h or more are rated using an EER. See above *efficiency conversions* for equipment not tested for an SEER.

See *SEER* and *EER* for the required efficiency levels for various types of air conditioners and heat pumps.

Airflow Across the Evaporator

The efficiency of air conditioners and heat pumps is affected by the airflow across the evaporator (or condenser in the case of a heat pump). Measuring the temperature split or temperature drop across the evaporator and comparing this measurement to reference tables can verify proper airflow. Appendix L has a procedure for verifying proper refrigerant charge and airflow. See also *Thermostatic Expansion Valves (TXV)*.

<i>Air Porosity</i>	Air porosity is a measure of the air-tightness of infiltration barriers in units of cubic feet per hour per square foot per inch of mercury pressure difference.
<i>Alteration</i>	An alteration is "any change to a building's water heating system, space conditioning system lighting system, or envelope that is not an addition." [§101]
<i>Alternative Calculation Method (ACM)</i>	An alternative calculation method is one of "the Commission's Public Domain Computer Programs or any other calculation method approved by the Commission." [§101]
<i>Alternative Component Packages</i>	An alternative component package is one of the sets of prescriptive requirements contained in § 151(f) and Tables 1-Z1 through 1-Z16 of the standards (Chapter 3). Each package is a set of measures that achieve a level of performance, which meets the standards. These are often referred to as the prescriptive packages or packages. "Buildings that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements of one of the alternative packages of components shown in Tables 1-Z1 through 1-Z16 for the appropriate climate zone..."
<i>ANSI</i>	American National Standards Institute.
<i>Appliance Efficiency Regulations</i>	"Appliance efficiency regulations are the regulations [standards] in Title 20, sections 1601 et. seq. of the California Code of regulations Title 24 California Code of Regulations." The <i>Appliance Efficiency Regulations</i> regulate the minimum efficiency of certain appliances, such as heating and cooling equipment, sold in California.
<i>Approved by the Commission</i>	"Approved by the Commission means approval under 25402.1 of the Public Resources Code." [§101].
<i>Approved Calculation Method</i>	See <i>Alternative Calculation Method</i> .
<i>Areal Heat Capacity</i>	Areal heat capacity is the amount of heat, in Btu, that can be stored per square foot of wall assembly by raising the average temperature of the wall assembly one degree Fahrenheit. See <i>Heat Capacity</i> .
<i>ARI</i>	Air-Conditioning and Refrigeration Institute.
<i>ASHRAE</i>	American Society of Heating, Refrigerating and Air-Conditioning Engineers.
<i>ASHRAE Handbook of Fundamentals</i>	A reference book published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers which includes industry accepted standard information on thermal properties of materials and HVAC system sizing. The standards reference both the 1993 and 1997 editions.
<i>ASME</i>	American Society of Mechanical Engineers.
<i>ASTM</i>	American Society for Testing and Materials.
<i>Back</i>	"Back" indicates the back side of the building as one faces the front facade from the outside (see <i>Front</i>). This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Back-West). See also <i>East-Facing</i> , <i>South-Facing</i> , etc.
<i>Btu/hr (Btu/h)</i>	British thermal unit per hour, also abbreviated Btu/h. One Btu equals the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit. Used for measuring heating and cooling equipment output.
<i>Building Envelope</i>	The Building Envelope is made up of the elements of a building that enclose conditioned spaces and through which thermal energy may be transferred to or from the exterior.

Building Location Data

Building location data refers to specific outdoor design conditions used in calculating heating and cooling loads. Different from the climate zone used for compliance (see *Climate Zone* below), design data includes the typically warmest and coolest outdoor temperatures that a building is likely to experience in an average year in its particular location.

Temperatures are from the ASHRAE publication, *SPCDX, Climatic Data for Region X - Arizona, California, Hawaii, Nevada*, May 1982 edition (see Appendix C). For heating, the outdoor design temperature is the Winter Median of Extremes. A higher temperature is permitted, but no lower than this value. For cooling, the outdoor design temperatures must be the 0.5 percent Summer Design Dry Bulb and the 0.5 percent Wet Bulb columns.

If a building location is not listed, the local enforcement agency may determine the location for which data is available that is closest in its design characteristics to the actual building site.

Building Types

Building type refers to the classification of buildings defined by the *UBC* and applicable to the requirements of the *Energy Efficiency Standards*. This manual is concerned with the energy standards that apply to all new low-rise residential buildings, which includes all single-family dwellings and multi-family buildings with three or fewer habitable stories in the entire building. This manual does not consider standards applicable to multi-family buildings with four or more habitable stories in the entire building, hotels, motels and officially designated historical buildings. A multi-family building contains multiple dwelling units that share common walls (single family attached) and may also share common floors or ceilings (apartments).

All new residential buildings not in the above low-rise category are covered in the 2001 edition of Energy Commission's *Nonresidential Manual for Compliance with Energy Efficiency Standards* (see Parts 1.1 and 1.2).

A single-family building is a single dwelling unit of occupancy group R-3, as defined in the *UBC*, which stands separate and unattached from other dwelling units but may have an attached garage.

A multi-family building is a dwelling unit of occupancy group R, as defined in the *UBC*, that shares a common wall and/or floor/ceiling with at least one other dwelling unit. See Chapter 8 for more information on multi-family energy compliance. A single family attached building is a dwelling unit of occupancy group R that shares a common wall with another dwelling unit.

An addition is an extension of or increase in conditioned floor area and volume of a building, which can be new construction or adding space conditioning to an existing space. See Chapter 7 for more information on energy compliance of additions.

An existing building is:

"...a building erected prior to the adoption of [the current] code, or one for which a legal building permit has been issued." [UBC, Part II, Section 403]

Climate Zone

The Energy Commission established 16 climate zones that represent a geographic area for which an energy budget is established. These energy budgets are the basis for the standards.

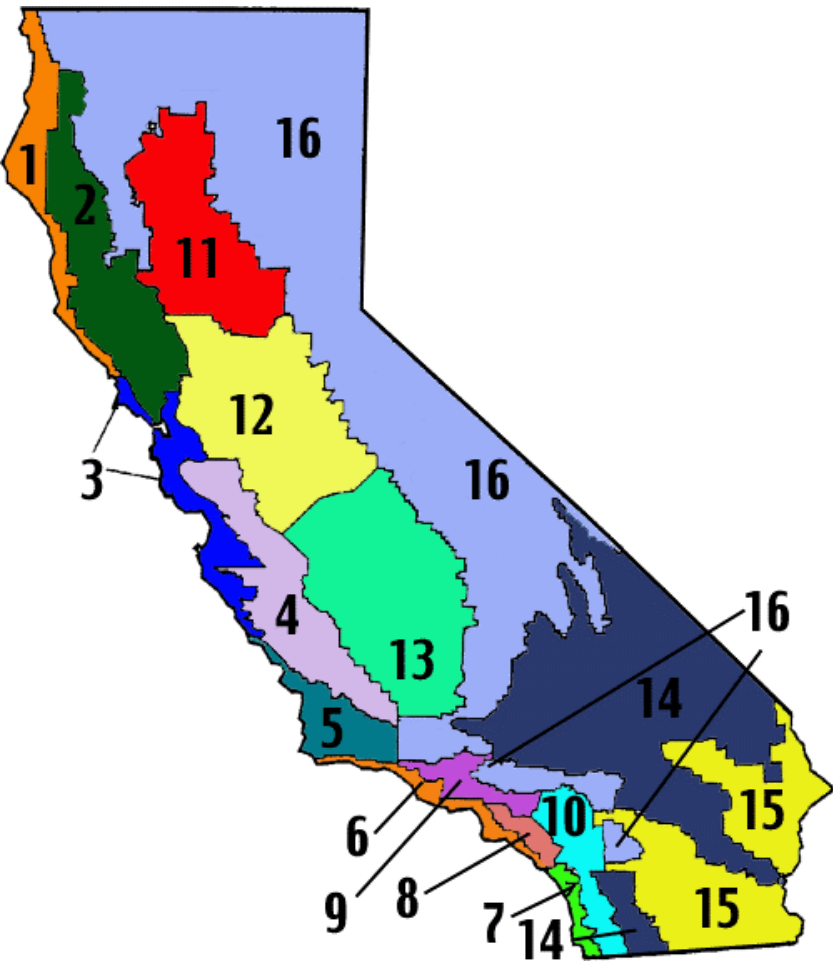
Figure G-1 is an overall map of the 16 climate zones. Appendix D contains a listing of the climate zone for most California cities. The Energy Commission publication *California Climate Zone Descriptions* (P400-95-041, July 1995) includes the same "Master Climate Zone Location Listing" for each city and the detailed climate zone boundary descriptions.

The Energy Commission originally developed weather data for each climate zone by using unmodified (but error-screened) data for a representative city and weather year (representative months from various years). The Energy Commission analyzed weather data from weather stations selected for (1) reliability of data, (2) currency of data, (3)

proximity to population centers, and (4) non-duplication of stations within a climate zone. Using this information, they created representative temperature data for each zone. The remainder of the weather data for each zone is still that of the representative city. The representative city for each climate zone (CZ) is as follows:

CZ1:	Arcata	CZ9:	Pasadena
CZ2:	Santa Rosa	CZ10:	Riverside
CZ3:	Oakland	CZ11:	Red Bluff
CZ4:	Sunnyvale	CZ12:	Sacramento
CZ5:	Santa Maria	CZ13:	Fresno
CZ6:	Los Angeles (AP)	CZ14:	China Lake
CZ7:	San Diego	CZ15:	El Centro
CZ8:	El Toro	CZ16:	Mount Shasta

Figure G-1:
California Climate
Zones



Coefficient of
Performance,
Cooling (COP)

The coefficient of performance for cooling is "...the ratio of the rate of net heat removal to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the *Appliance Efficiency Regulations* or § 112." [§101]

COP and EER values may be interchanged according to the following conversion:

$$3413 \text{ Btu} = 1 \text{ kWh}$$

Therefore,

$$\text{COP} = \text{EER} / 3.413 = 0.293 \times \text{EER}$$

$$\text{EER} = 3.413 \times \text{COP}$$

When heat pump equipment is tested for COP and not HSPF, the following conversions may be assumed:

Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed)

Central air conditioning heat pumps = (3.2 x COP) - 2.4 = HSPF

See *Heating, Ventilating and Air Conditioning; EER, HSPF and SEER*.

Coefficient of Performance, Heating (COP)

The coefficient of performance for heating is "...the ratio of the rate of net heat output to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or §112." For residential buildings, the COP is used for large heat pumps, those with a capacity greater than 65,000 Btu/h. See §112, Table 1-C2 for the requirements.

See also *Air Conditioner, EER (Energy Efficiency Ratio), HSPF (Heating Seasonal Performance Factor), SEER (Seasonal Energy Efficiency Ratio)*

Combined Hydronic Space/Water Heating

A combined hydronic space conditioning and water heating system is one in which both domestic hot water and space heating is supplied from the same water heating equipment. Combined hydronic space heating includes both radiant floor systems and convective or fan coil systems. The method for analyzing combined hydronic space and water heating systems is explained in Chapter 6 and Chapter 8.

Commission

California Energy Commission, also known as the State Energy Resources Conservation and Development Commission. The Energy Commission was established by the Warren-Alquist Act contained in the Public Resources Code. Its mandate, in part, is to develop and implement building energy efficiency standards as described in this manual. See also Chapter 1.

Compliance Documentation

There are several forms used to demonstrate compliance with the standards that are recommended for submittal to the local enforcement agency. Table G-2 contains a list of these forms. A copy of each recommended form is contained in Appendix A of this manual. Similar forms, such as those produced by approved computer programs, are also allowed to be used for compliance submittals as long as the information is the same and the format is similar [§10-103(a)(2)(C)]. In addition to the forms described below, additional information must accompany the compliance documentation:

Plans and Specifications

Plans and specifications showing the characteristics of each feature, material, component, and manufactured device proposed to be installed in order to have the building meet the requirements of the standards. If any characteristic is materially changed before final construction and installation and there is any question that the building might no longer comply with the standards, the building must be brought back into compliance and amended plans, specifications, and Certificate(s) of Compliance must be submitted to the enforcement agency. [§10-103(a)(2)(B)]

Heating and Cooling Load Calculations

Load calculations are performed as described in Chapter 2 under Space Conditioning Equipment Sizing. They need not be submitted unless requested by the local building department.

The **forms** are summarized below:

Certificate of Compliance: Residential (CF-1R)

A Certificate of Compliance summarizing all conservation features and devices required for energy compliance of the residential building must be submitted, regardless of the compliance approach. This form must be signed by the designer or person responsible

for construction and the building owner (see Chapter 1). The CF-1R must be included “on” the building plans (*EES*, Sec 10-103(a)(2)(A)).

Mandatory Measures Checklist (MF-1R)

This checklist is used by the building plan checker and field inspector to verify compliance of the building with the prescribed list of mandatory features, equipment efficiencies and product certification requirements. The documentation author indicates compliance by initialing, checking, or marking N/A (for features not applicable) in the boxes or spaces provided for the designer.

Computer Method (C-2R)

If a computer performance method is used for compliance, a detailed input report or C-2R form is generated by the approved program summarizing the input assumptions used in the analysis of the building. Approved computer programs automatically generate all required forms (see Chapter 5).

No equivalent form is needed for compliance with a prescriptive package (see Chapter 3).

**Table G-2:
Typical
Compliance Forms
Needed for Each
Compliance Path**

Form	Prescriptive Package	Computer Method
CF-1R	Required	Required
MF-1R	Required	Required
C-2R	Not applicable	Required
WS-1R	If applicable	Not applicable
Form 3R	If applicable	If applicable
Water Heating ¹	If applicable	Not applicable
Form S	If applicable	If applicable
Load Calc. ²	If applicable	If applicable
IC-1	Required	Required
CF-4R	Not applicable	If applicable
CF-6R	Required	Required

1 Required for all non-standard water heating systems as defined in Chapter 6, except for Prescriptive Package compliance analyses with water heating systems listed in Table 3-4. Calculations may be on the worksheets which accompany the water heating method (see Chapter 6). Water heating calculations are automatically included in the approved computer methods so no additional water heating forms are required for those compliance paths.

2 Load calculations must be performed, but need not be submitted unless requested by the local building department.

Proposed Construction Assembly (Form 3R)

A proposed construction assembly (Form 3R) need *not* be submitted for:

- Prescriptive compliance, if the insulation R-value meets or exceeds the package requirement and the frame type is wood; or
- The computer performance method, if the standard default U-factors from Table G-15 for particular levels of insulation are assumed.

See *R-value* for instructions on completing Form 3R.

Water Heating Calculations

Water heating calculations are *not* required for the following water heating systems:

- (1) Non-recirculating gas type heater with a storage tank of 50 gallons or less that meets the minimum appliance standards, and for any water heater with an energy factor of less than 0.58 includes an R-12 external insulation wrap; or
- (2) Prescriptive Package compliance analyses with water heating systems listed as a “Y” in Table 3-14; or
- (4) Compliance analyses with approved computer methods (these programs automatically perform all required water heating calculations internally).

	See Chapter 6 for complete instructions on the water heating method.
Solar Heat Gain Coefficient Worksheet (Form S)	Documentation of solar heat gain coefficient calculations. Form S is not required to document solar heat gain coefficients taken from Table G-8.
Thermal Mass Worksheet (WS-1R)	A worksheet to document (1) the thermal mass goal of Alternative Component Package C and (2) the building's interior thermal mass to gain compliance.
Insulation Certificate (IC-1)	This form must be completed by the insulation installer or general contractor.
Certificate of Field Verification and Diagnostic Testing (CF-4R)	<p>This certificate is completed by a HERS rater for each home that uses performance (computer) compliance credits that require diagnostic testing and field verification by a HERS rater such as improved duct efficiency or reduced envelope leakage.</p> <p>The requirements for this certificate and the information on this form are spelled out in detail in Chapter 4.</p>
Installation Certificate (CF-6R)	<p>An installation certificate must be completed by the installer of each manufactured device (i.e., appliances and fenestration products) or by the general contractor for all devices regulated by the <i>Appliance Efficiency Regulations</i>, or the standards.</p> <p>This form must either be posted at the job site or made available to the inspector. When completed, a copy of this form must also be provided to the first occupant of the building. See Chapter 1 for additional information about this form.</p> <p>This manual includes the recommended version of the Installation Certificate for residential buildings. This particular form is not required, but the information it includes must be on any alternate version.</p>
Conditioned Floor Area (CFA)	<p>Conditioned floor area (CFA) is the [total] floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space. [§101]</p> <p>This term is also referred to in the standards simply as the floor area.</p> <p>This is an important value for the purpose of compliance since annual energy use is divided by this value to obtain the energy budget. In the prescriptive packages, fenestration area is expressed as a percentage of this value.</p> <p>CFA is calculated from the plan dimensions of the building including the floor area of all conditioned and indirectly conditioned space on all floors (see definition of <i>Indirectly Conditioned Space</i>). It includes lofts and mezzanines but does not include covered walkways, open roofed-over areas, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs or parking garages. Unheated basements or closets for central gas forced air furnaces are also not included unless shown to be indirectly conditioned.</p> <p>The floor area of an interior stairway is determined as the CFA beneath the stairs and the tread area of the stairs themselves.</p> <p>See Figure G-2 for an example of total CFA.</p>

Figure G-2: Total
Conditioned Floor
Area

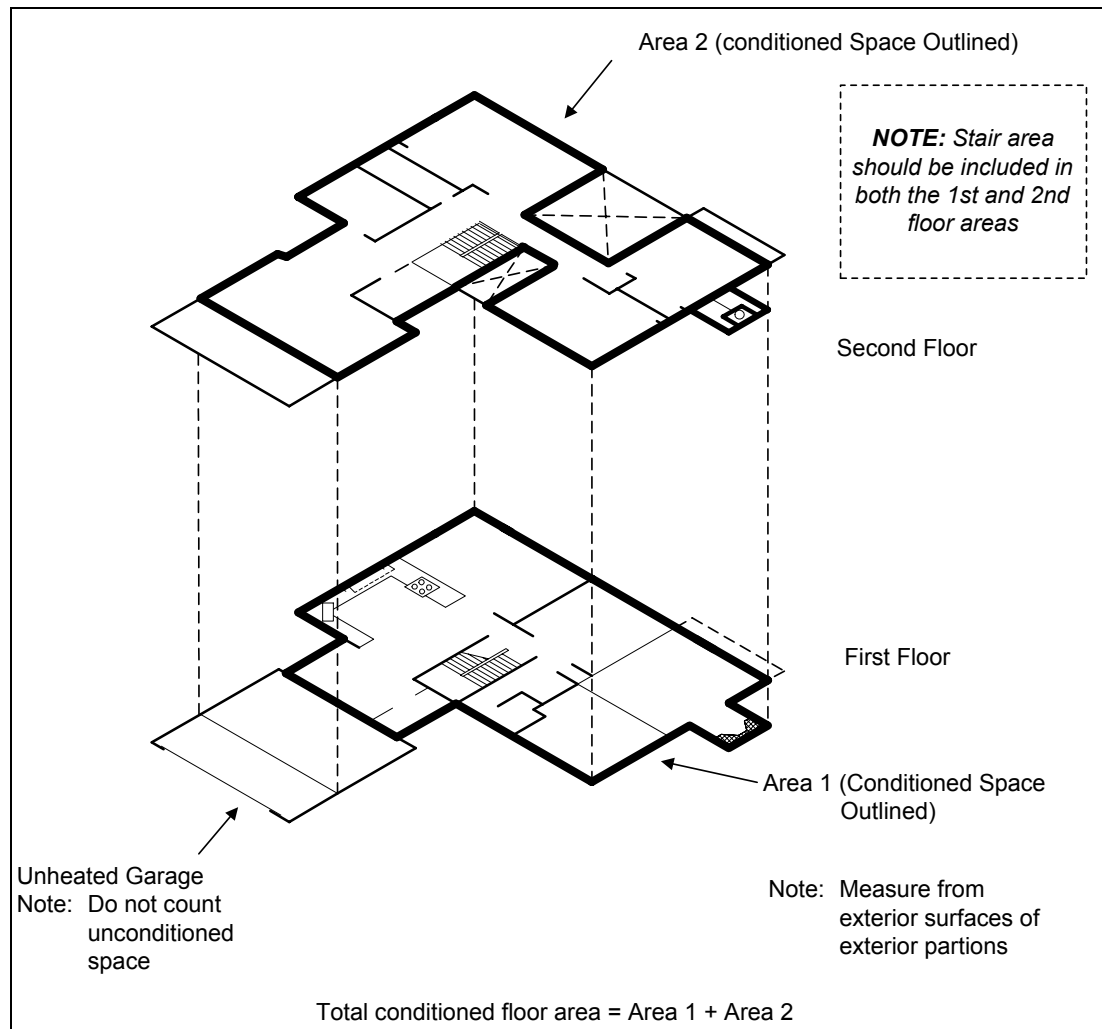
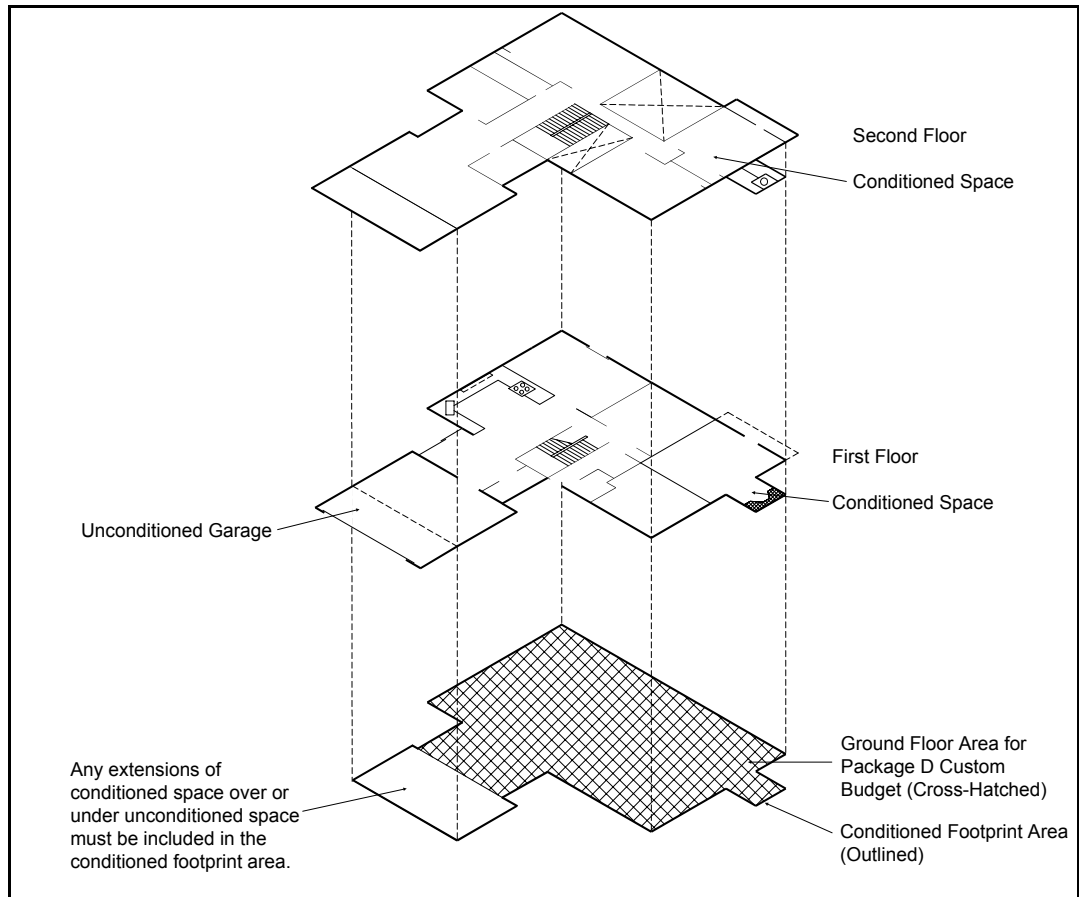


Figure G-3:
Conditioned
Footprint Area



Conditioned Footprint Area

The conditioned footprint is the total area of the building footprint, in square feet, not including unconditioned space. The conditioned footprint area may be equal to the first floor area, or it may be greater. The footprint area is the total area of floor over unconditioned space (not over conditioned space), ambient air and slab-on-grade. One way to think of the conditioned footprint area is as the area of the largest conditioned floor in the building plus the conditioned floor area of any projections from other stories that extend beyond the outline of that largest floor.

See Figure G-3 for an example of conditioned footprint area. See also *Ground Floor Area, Raised Floor, and Slab-on-Grade*.

Conditioned Space

In residential compliance, conditioned space is space in a building that is either directly conditioned or indirectly conditioned. [§101]

Controlled Ventilation Crawl Space (CVC)

The Energy Commission has approved an exceptional method for analyzing the energy impact of buildings with raised floors which use foundation wall insulation and have automatically controlled crawl space vents. The method is available as an option using an approved computer method with unique modeling criteria explained in Chapter 5, following installation guidelines found in Chapter 8.

Converting Efficiencies

When equipment is not tested for SEER, the EER may be used as the SEER. When heat pump equipment is not tested for HSPF, the following conversions may be assumed:

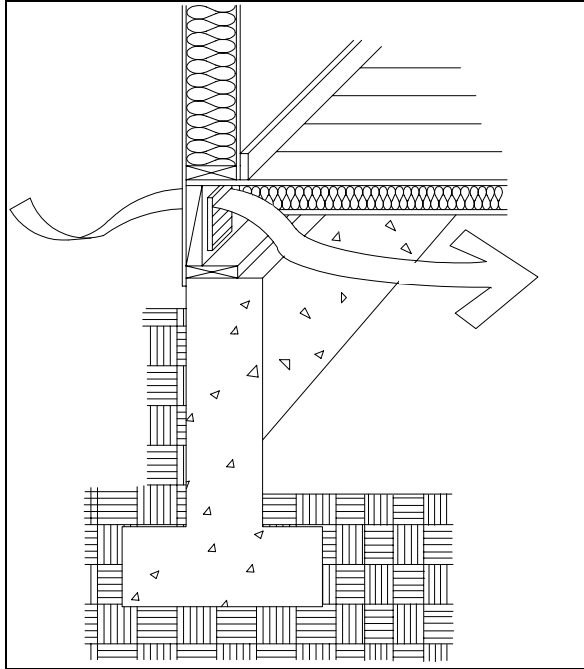
Through-the-wall heat pump = 6.6 HSPF

Central air conditioning heat pumps that do not have an HSPF rating for heating but have a COP rating, $HSPF = (3.2 \times COP) - 2.4$

<i>Cooling Load</i>	The rate at which heat must be extracted from a space to maintain a desired room condition.
<i>Cooling Load Temperature Difference (CLTD)</i>	An equivalent temperature difference used for calculating the instantaneous external cooling loads across a wall or roof ($CLTD = \text{External Cooling Load} / (U\text{-factor} \times \text{Area})$). When used for glass, the CLTD calculates only the conduction cooling load.
<i>Cool Roof</i>	A cool roof is a roof surface with a high reflectivity and high emittance. To qualify as a cool roof with the standards, the initial reflectivity must be greater than 0.40 for concrete and clay tile roofs and 0.70 for all other roofs. The emittance must be greater than 0.75. A cool roof rejects solar heat before it enters the building by reflecting it back to the atmosphere. The reflectivity of the roof surface is a measure of the ability of a roofing surface to reject heat. The higher the reflectivity, the more heat is rejected. A surface with a high reflectivity has a low absorptivity and vice versa. The sum of the absorptivity and reflectivity is always equal to one. The emittance of the roof surface is an indication of the ability of a roof surface to release heat after it has already entered the roof construction. A high emittance means that the surface can easily radiate heat back to the sky.
<i>Cool Roof Rating Council (CRRC)</i>	<p>The CRRC is a not-for-profit organization with responsibility to rate and label cool roof products. The CRRC is the supervisory entity designated by the Energy Commission; this authority is granted in §10-113 of the standards. After January 1, 2003, all qualifying cool roof products must be labeled by the CRRC. The responsibilities of the CRRC include:</p> <ol style="list-style-type: none"> 1. Maintain an open, nondiscriminatory, and broad membership of persons or organizations with an interest in uniform performance ratings for roofing products. 2. Maintain a governing body that reflects a reasonable cross-section of the interests represented by the membership. 3. Maintain a program of oversight of product manufacturers, laboratories, and independent certifying organizations that ensures uniform application of the testing and labeling system. 4. Accredite laboratories to perform the required tests and require manufacturers to use these accredited laboratories. 5. Maintain appropriate guidelines for testing laboratories and manufacturers, including requirements for adequate: possession and calibration of equipment; education, competence, and training of personnel; quality control; record keeping and reporting; periodic review; challenges to certified ratings; and guidelines to maintain the integrity of the program. 6. Maintain reasonable, nondiscriminatory fee schedules for the services it provides. 7. Provide hearing processes that give laboratories, manufacturers and certifying agencies a fair review of decisions that adversely affect them. 8. Avoid conflicts of interest in deciding appeals, resolving disputes and setting policy for the certifying organizations in its program. 9. Publish at least annually a directory of products certified and decertified within its program. 10. Be free from conflict-of-interest ties or to undue influence from any particular roofing product manufacturing interest(s), testing or independent certifying organization(s). 11. Provide or authorize the use of labels that can be used with the standards. 12. Provide for competition between manufacturers and competition between testing laboratories.
<i>Crawl Space</i>	A crawl space is a space immediately under the first floor of a building adjacent to grade that meets the under-floor clearance requirements of the UBC [§101]

The thermal characteristics of a crawl space (or any similar vented unheated space below a raised floor) tend to reduce heat loss and heat gain into the building compared with an open, unprotected space below the floor. Compliance credit for the crawl space is assumed to be equivalent to an additional R-6 insulation value (see *Insulation, R-Value*, Figures G-4 and G-8). R-6 insulation is *not modeled* when a raised floor is over an open area or over a garage.

Figure G-4: Crawl Space



An exceptional method for analyzing the energy impact of buildings with raised floors that use foundation wall insulation and automatic crawl space vent dampers has been approved by the Energy Commission and is described under *Controlled Ventilation Crawl Space* in this Glossary and Chapter 8.

Custom Energy Budget

See *Energy Budget*.

Decorative Gas Appliance

A decorative gas appliance is a "gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace." [§101]

A decorative gas appliance installed in a new residential building or addition cannot contain a continuously burning pilot light, and cannot use indoor air for cooling a firebox jacket if the indoor air is vented to the outside of the building. [§101, 151(e)]

N.B.: Appliances that use indoor air for combustion cannot be used where compliance credit is taken for reduced building infiltration.

Degree Day, Heating

A heating degree day is "a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F." [§101]

Design Conditions

"Design conditions are the parameters and conditions used to determine the performance requirements of space conditioning systems. Design conditions for determining design heating and cooling loads are specified . . . in § 150(h) for low-rise residential buildings." [§101]

<i>Design Heat Gain</i>	The design heat gain is "...the total calculated heat gain through the building envelope under design conditions." [§101]
<i>Design Heat Loss</i>	The design heat loss is "...the total calculated heat loss through the building envelope under design conditions." [§101]
<i>Directly Conditioned Space</i>	"Directly conditioned space is an enclosed space that is provided with wood heating, is provided with mechanical heating that has a capacity exceeding 10 Btu/(hr×ft ²), or . . . mechanical cooling that has a capacity exceeding 5 Btu/(hr×ft ²), unless the space conditioning system is designed and thermostatically controlled to maintain a process environment temperature less than 55°F or to maintain a process environment temperature greater than 90°F for the whole space that the system serves, or unless the space conditioning system is designed and controlled to be incapable of operating at temperatures above 55°F or incapable of operating at temperatures below 90°F at design conditions." [§101]
<i>Dominant Occupancy</i>	In mixed occupancy buildings, the dominant occupancy is the occupancy type with the greatest percentage of total conditioned floor area.
<i>Door</i>	See <i>Exterior Door</i> .
<i>Dual-Glazed Greenhouse Windows</i>	"Dual-Glazed Greenhouse Windows are a type of dual-glazed fenestration product which adds conditioned volume but no conditioned floor area to a building." [§101]
<i>East-Facing</i>	<p>"East-facing is oriented to within 45 degrees of true east, including 45°0'0" south of east (SE), but excluding 45°0'0" north of east (NE)." [§101]</p> <p>This definition applies only to the prescriptive packages and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.</p> <p>The designation "East-Facing" is also used in production buildings using orientation restrictions (e.g., Shaded Areas: East-Facing). See Chapter 8.</p>
<i>EER (Energy Efficiency Ratio)</i>	<p>The energy efficiency ratio (EER) is "the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy (in watts), of a cooling system under designated operating conditions, as determined using the applicable test method in the Appliance Efficiency Regulation or § 112." [§101]</p> <div style="border: 1px solid black; padding: 5px;"> <p>Note. Since few residential buildings use air conditioners or heat pumps with an output capacity greater than 65,000 Btu/h, the Low-Rise Residential Standards are expressed in terms of SEER and HSPF ratings, not EER or COP.</p> </div> <p>The EER of all central air conditioners and central heat pumps with output of 65,000 Btu/h and over, manufactured on or after January 1, 1992, and all room air conditioners and room air conditioner heat pumps of 200 volts or more, manufactured on or after January 1, 1990, shall be certified by the manufacturer to comply with values listed in Table G-3</p>

Table G-3A: EER Requirements for Large Central Air Conditioners

Equipment Type	Size Category	EER
Central Air Conditioners	65,000 Btu/h and over (up to 135,000 Btu/h)	8.9
Central Air Source Heat Pumps	65,000 Btu/h and over (up to 135,000 Btu/h)	8.9
Central Water Source Heat Pumps	Up to 65,000 Btu/h	9.3
	65,000 Btu/h and over (up to 135,000 Btu/h)	10.5

Table G-3B: Non-Central Space Cooling Equipment

Including Package Terminal Air Conditioners (PTAC); Package Terminal Heat Pumps (PTHP); Room Air Conditioners; and Room Air Conditioner Heat Pumps

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
PTAC (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000) ^b EER	ARI 310/380
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000) ^b EER	
PTHP (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000) ^b EER	ARI 310/380
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000) ^b EER	
PTHP (Heating Mode)	All Capacities		2.9 - (0.026 x Cap/1000) ^b COP	
Room Air Conditioners, with Louvered Sides	< 6,000 Btu/h		8.0 EER	ANSI/AHAM RAC-1
			8.5 EER	
			9.0 EER	
			8.8 EER	
			8.2 EER	
Room Air Conditioners, without Louvered Sides	< 6,000 Btu/h		8.0 EER	
			8.5 EER	
			8.2 EER	
Room Air Conditioner Heat Pumps with Louvered Sides	All Capacities		8.5 EER	
Room Air Conditioner Heat Pumps without Louvered Sides	All Capacities		8.0 EER	
Room Air conditioners & Room Heat Pumps Not Covered by Federal Regulations				
Room Air Conditioners & Heat Pumps	200 volts or more		8.2 EER	10 Code of Federal Regs.
Room Air Conditioners	Less than 200 volts		8.7 EER	Section
Room Heat Pumps			8.3 EER	430.22(f)

^b Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

^c Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

COP and EER values may be interchanged according to the following conversion:

$$3413 \text{ Btu} = 1 \text{ kWh}$$

Therefore,

$$\text{COP} = 0.293 \times \text{EER, and}$$

$$\text{EER} = 3.413 \times \text{COP}$$

For equipment that is not tested for SEER the EER may be used as the SEER.

See *Heating, Ventilating and Air Conditioning; COP and SEER*.

Efficacy

"Efficacy is the ratio of light from a lamp to the electrical power consumed (including ballast losses), expressed in lumens per watt." [§101]

See also *Lumens/Watt*.

*Electric
Resistance
Heating*

As mentioned in the explanation of *Energy Budget* in this *Glossary*, electricity is inherently less efficient than gas as a heating energy source because it must account for losses associated with generation from depletable fossil fuels and transmission to the building site. A source energy multiplier of 3.0 (representing a net efficiency of 33 percent) is assigned to electricity by the standards. Table G-11 lists the number of Btu of source energy per kilowatt-hour of electricity.

Electric resistance baseboard heaters are assumed to have a property line efficiency of 1.00 and an equivalent HSPF of 3.413.

Electric radiant heating panels may be assigned a slightly higher efficiency of 1.04 (equivalent HSPF of 3.550) owing to their mode of delivering sensible heat if the following criteria are met:

1. The radiant heating is installed on the interior surface of the building envelope.
2. The radiant surface is not likely to be behind furnishings (i.e. it is installed high on a wall or on a ceiling).
3. The radiant surface is not designed with fins or covers.
4. The radiant surface does not use a fan to deliver its heat.

Supplemental electric resistance heaters to central space heating systems are not modeled in the energy compliance calculations. An air supply register from the central system must be located in the same room as the electric resistance heater in order for the electric resistance heater to be considered supplementary.

Enclosed Space

"Enclosed space is space that is substantially surrounded by solid surfaces." [§101]

Energy Budget

"Energy budget is the maximum amount of source energy that a proposed building, or portion of a building, can be designed to consume, calculated with the approved procedures specified in Title 24, Part 6." [§101]

The low-rise residential standards are based upon the concept of an annual energy budget. This is the measure of source energy used per year in a building. The energy budget for low-rise residential buildings includes space heating, space cooling and domestic water heating. To comply with the standards, the energy use of the proposed building design must be less than the annual energy budget.

The standard design is made up of features required in prescriptive package D and are used to determine the annual energy budget. Each approved computer method automatically generates a custom energy budget by calculating the annual energy use of the standard design.

The energy budget allows a "trade-off" of part of the space conditioning budget for part of the water heating budget, or vice versa. This is explained further in Chapter 5.

The space conditioning component of the energy budget is measured in thousands of British thermal units (kBtu) consumed per square foot of conditioned floor area per year. Water heating is calculated in kBtu per dwelling unit per year and then divided by the building floor area to convert to kBtu per square foot per year.

Source energy accounts for all of the energy used in delivering energy to the building site including power generation, transmission and distribution. See *Source Energy* for conversion rates. See Table G-11 for source energy conversion rates for electricity, natural gas, fuel oil and propane.

See also *Proposed Design*, *Standard Design* and *Source Energy*.

Energy Efficiency Standards

The California state energy standards as set forth in the California Code of Regulations, Title 24, Part 6 (see Chapter 1).

Energy Factor (EF)

Used to measure the efficiency of water heaters, the Energy Factor (EF) is "the ratio of energy output to energy consumption of a water heater, expressed in equivalent units, under designated operating conditions over a 24-hour use cycle, as determined using the applicable test method in the Appliance Efficiency Regulations." [§101]

The Energy Factor of all new small water heaters manufactured on or after April 15, 1991 shall be certified to be not less than the following:

Water Heater Type	Energy Factor
Gas	0.62 - (.0019 x V)
Electric (including heat pump)	0.93 + (.00132 x V)
Oil	0.59 - (.0019 x V)
"V" equals rated volume in gallons.	

Energy Obtained From Depletable Sources

"Energy obtained from depletable sources is electricity purchased from a public utility, or energy obtained from burning coal, oil, natural gas, or liquefied petroleum gases." [§101]

Energy Obtained From Nondepletable Sources

Also referred to as renewable energy, including solar and wind power, energy from non-depletable sources is defined as energy that is not obtained from depletable sources. [§101]

Enforcing Agency

The enforcing agency is "the city, county, or state agency responsible for issuing a building permit." [§101]

Evaporative Cooler

Evaporative coolers may be installed as an alternative to air conditioning, particularly in climate zones with dry air. These systems use water evaporation and air circulation to provide cooling. Evaporative coolers use less energy for cooling than minimum efficiency air conditioners, so the Energy Commission has established higher SEERs to use when modeling them for compliance. See Chapter 8 for details on this credit, including eligibility and installation criteria.

Evaporative coolers provide cooling to a building by either direct contact with water (direct evaporative cooler), or a combination of a first stage heat exchanger to pre-cool building air temperature and a second stage with direct contact with water (indirect/direct evaporative cooler).

Credit for evaporative coolers is allowed in either single-family detached or single-family attached residences. *No credit is allowed for evaporative coolers in multi-family buildings.* See Chapter 8 for the credit and installation criteria.

NOTE:

In hot and humid climates, the following characteristics of evaporative cooling should be considered:

- Direct evaporative coolers in climates that are both hot and humid may result in uncomfortable indoor humidity levels.
- Indirect/direct evaporative coolers do not increase indoor humidity as much as direct systems, and would be unlikely to produce uncomfortable indoor humidity levels, even in hot, humid areas.
- Evaporative coolers may not reduce indoor temperatures to the same degree as air conditioning.

See Chapter 8.

Exceptional Method

If an "alternative calculation method [ACM] analyzes designs, materials, or devices that cannot be adequately modeled using the public domain computer programs, the method may be approved [by the Commission] as an exceptional method. Applications for approval of exceptional methods shall include theoretical and empirical information that verify the method's accuracy, and shall also include the other documentation and fees required by sub§ 10-109(b)." [§10-109(b)4]

Two examples of exceptional methods are the controlled ventilation crawl space (CVC) credit (see *Glossary* entry and Chapter 8) and the combined hydronic space and water heating method (see Chapter 5 and Chapter 8). Other exceptional methods are also included in Chapter 8. Exceptional methods can be approved at any time. The Energy Commission distributes a public notice whenever such methods are approved with instructions for achieving the allotted credit.

Exfiltration

Exfiltration is unwanted conditioned air leakage from a building. This term is usually mentioned in conjunction with infiltration. All compliance approaches require some type of infiltration/ exfiltration controls as described later in this Glossary and in Chapter 2.

Exterior Door

An exterior door is any openable opaque surface that separates conditioned and unconditioned space. A door with one half or less of the surface area as glazing is an exterior door. A door with more than 50 percent of its surface area made up of glazing is a fenestration product. [§101] This distinction affects labeling and certification requirements for the product.

Glass in doors must be counted as part of the total fenestration area. The area to be included must be either the entire door area or the actual area of the glazing plus a two inch frame extension on all sides.

Any door that receives an NFRC rating should be modeled as an entire fenestration unit with the rated U-factor and solar heat gain coefficient (these values are based on the entire product, including the framing).

Solid (opaque) door area is ignored in the prescriptive packages but must be included in the computer performance approach (see Chapter 5).

Exterior Floor/Soffit

An exterior floor or soffit is "a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include those on grade." [§101]

Exterior Partition

An exterior partition is "an opaque, translucent, or transparent solid barrier that separates conditioned space from ambient air [outdoors] or space that is not enclosed. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground." [§101]

<i>Exterior Roof/Ceiling</i>	An exterior roof or ceiling is "...an exterior partition, or a demising partition, that has a slope less than 60 degrees from horizontal, that has conditioned space below, and that is not an exterior skylight." [§101]
<i>Exterior Wall</i>	An exterior wall "is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building and which has a slope of 60 degrees or greater with the horizontal plane. An exterior wall or partition is not an exterior floor/soffit, exterior door, exterior roof/ceiling, window, skylight, or demising wall. [§101]
<i>Exterior Wall Area</i>	<p>"Exterior wall area is the area of the opaque exterior surface of exterior walls." [§101]</p> <p>An exterior wall is distinguished from an exterior roof/ceiling by its angle of tilt. A wall is a surface with a tilt of greater than or equal to 60 degrees measured from the horizontal.</p> <p>The area of bermed (underground) walls between conditioned space and below grade is treated differently depending on the compliance approach. See Chapter 3 (prescriptive) or Chapter 5 (computer) for the correct procedures for below grade walls in a conditioned space.</p>
<i>Fenestration Area (Glazing Area)</i>	<p>Fenestration area is defined as the area of all fenestration products (i.e., windows, skylights and glass doors) in exterior openings, including the sash or frame area. The nominal area (from nominal dimensions such as 4'0"4'0") or rough opening is also acceptable.</p> <p>For details on calculating fenestration area for glass doors, see <i>Exterior Door</i>.</p> <p>Where the term "glazing area" is used in the standards it means the entire fenestration area, not just the area of glazing, unless stated otherwise (see Figure G-5).</p> <p>See <i>Fenestration Product, Glazing and Shading</i>.</p>
<i>Fenestration Product</i>	<p>A fenestration product is: "any transparent or translucent material plus any sash, frame, mullions, and dividers, in the envelope of a building, including, but not limited to: windows, sliding glass doors, french doors, skylights, curtain walls, garden windows, and other doors with a glazed area of more than one-half of the door area." [§101]</p> <p>Table G-4 contains default values for fenestration product U-factor from § 116 of the standards. Default values for Solar Heat Gain Coefficient are found under the heading <i>Shading</i> in this Glossary. Additional information contained in this manual is:</p> <p>An explanation of glazing terminology and thermal performance rating system for all fenestration products in Chapter 8.</p> <p>Certification, labeling and mandatory requirements for fenestration products are included in Chapter 2.</p> <p>Additions and alterations compliance issues related to fenestration are discussed in Chapter 7.</p> <p>Fenestration topics related to prescriptive and computer compliance are found in Chapters 3 and 5.</p>
<i>Fireplace</i>	<p>A fireplace is a "hearth and fire chamber or similar prepared place in which a solid fuel fire may be burned, as defined in UBC Section 3102 ; these include but are not limited to factory-built fireplaces, masonry fireplaces, and masonry heaters." [§101]</p> <p>See Chapter 2 for mandatory requirements regarding fireplace installation.</p>
<i>Floor Area</i>	See <i>Conditioned Floor Area</i> .
<i>Footprint Area</i>	See <i>Conditioned Footprint Area</i> .
<i>Fossil Fuels</i>	Fossil fuels are fuels which are derived from natural gas, coal, oil and liquefied petroleum products. These are generally nonrenewable resources, although natural gas may also be produced by other means, such as biomass conversion.

<i>Framing Effects</i>	The type and amount of framing in walls, roofs/ceilings and floors affects the overall U-factor of the surface. For compliance, fixed values for wood framing percentages must be used when a parallel path U-factor is calculated. Alternatively, precalculated U-factors that include frame effects may be used for both wood and metal frame assemblies. Refer to Tables G-12 through G-16 and the <i>R-Value</i> discussion of this Glossary.
<i>Front</i>	<p>The primary entry side of the building (front facade) used as a reference in defining the orientation of the building or unit plan (see Chapter 5). The orientation of the front facade may not always be the same as that for the front door itself.</p> <p>This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of a custom building (e.g., Front Entry Orientation: North). See also <i>North-Facing</i>, <i>East-Facing</i>, etc.</p>
<i>Gas Heating System</i>	See <i>Heating, Ventilation and Air Conditioning</i> .
<i>Gas Log</i>	A gas log is "a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs and designed for installation only in a vented fireplace." [§101]

Table G-4:
Default
Fenestration
Product U-factors

Frame Type ¹	Product Type ²	Single Pane U-factor	Double Pane U-factor ³
Metal	Operable	1.28	0.87
	Fixed	1.19	0.72
	Greenhouse/Garden window	2.26	1.40
	Doors	1.25	0.85
	Skylight	1.72	0.94
Metal, Thermal Break	Operable		0.71
	Fixed		0.60
	Greenhouse/Garden window		1.12
	Doors		0.64
	Skylight		0.80
Non-Metal	Operable	0.99	0.60
	Fixed	1.04	0.57
	Doors	0.99	0.55
	Greenhouse/Garden window	1.94	1.06
	Skylight	1.47	0.68

1 Metal includes any field-fabricated product with metal cladding. Non-metal framed manufactured fenestration products with metal cladding must add 0.04 to the listed U-factor. Non-Metal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

- The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr/ft²/°F,
- The thermal break must produce a gap of not less than 0.210", and
- All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break. In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard.

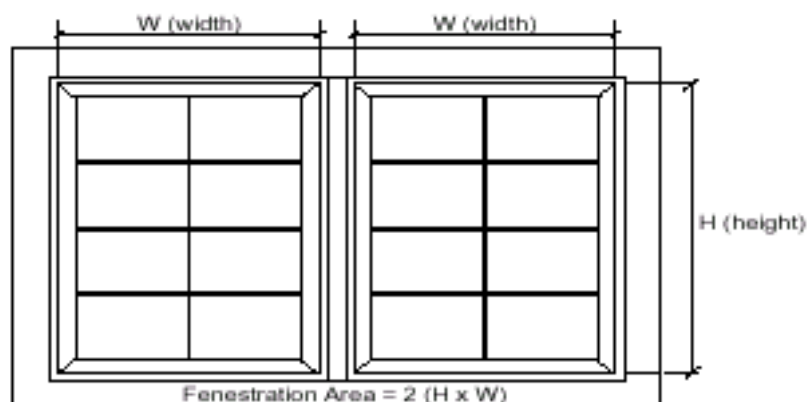
The values for non-metal can be used for unframed windows

2 Glass Block may use the values for double pane windows of the same frame type used with the glass block.

3 For all dual glazed fenestration products, adjust the listed U-factors as follows:

- Subtract 0.05 for spacers of 7/16" or wider.
- Subtract 0.05 for products certified by the manufacturer as low-E glazing.
- Add 0.05 for products with dividers between panes if spacer is less than 7/16" wide.
- Add 0.05 to any product with true divided light (dividers through the panes).

Figure G-5:
Fenestration Area



<i>General Lighting</i>	<p>"General lighting is lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect. When designed for lower-than-task illuminance used in conjunction with other specific task lighting systems, it is also called "ambient" lighting."</p> <p>As used for kitchen lighting, general lighting must provide a sufficient light level for basic kitchen tasks and provide a uniform pattern of illumination. These requirements are in §150(k)1.</p> <p>See also <i>Lighting</i>.</p>
<i>Geothermal Heat Pump</i>	<p>A heat pump that uses the earth as a source of energy for heating and a sink for energy when cooling. Some systems pump water from an aquifer in the ground and return the water to the ground after transferring heat from or to the water. A few systems use refrigerant directly in a loop of piping buried in the ground. Those heat pumps that use either a water loop or pump water from an aquifer have efficiency test methods that are accepted by the Energy Commission. These efficiency values are certified to the Energy Commission by the manufacturer and are expressed in terms of heating Coefficient of Performance (COP) and cooling Energy Efficiency Ratio (EER).</p>
<i>Glazing</i>	<p>Glazing is defined as the translucent portion of any fenestration product, typically glass.</p> <p>See <i>Fenestration Product</i>, <i>Shading</i> and Chapter 8.</p>
<i>Ground Floor Area</i>	<p>For compliance, the ground floor area is defined as the slab-on-grade area of a slab-on-grade building and the conditioned footprint area of a raised floor building.</p>
<i>Ground Source Heat Pump</i>	<p>See <i>Geothermal Heat Pump</i>.</p>
<i>Habitable Story</i>	<p>A habitable story in a building is a story that "contains space in which people may work or live in reasonable comfort. A habitable story is defined as having at least 50 percent of its volume above grade." [§101] The standards use this definition to determine whether a building is high-rise or low-rise.</p> <p>See also <i>Conditioned Floor Area</i>, <i>High-Rise Residential</i> and <i>Low-Rise Residential</i>.</p>
<i>Heat Capacity (HC)</i>	<p>The heat capacity of an assembly is "the amount of heat necessary to raise the temperature of all the components of a unit area in the assembly one degree F. It is calculated as the sum of the average thickness times the density times the specific heat for each component, and is expressed in Btu per square foot per degree F." [§101]</p> <p>See <i>Areal Heat Capacity</i>.</p>
<i>Heat Pump</i>	<p>A heat pump is an air conditioner capable of heating by refrigeration. It may or may not include a capability for cooling. Outside air or water is used as a heat source or heat sink, depending upon whether the system is heating or cooling.</p> <p>Heat pump efficiency is measured according to the HSPF rating (see HSPF) which is a function of both the condensing unit (compressor) and the type of coil selected to be used with it. Equipment manufacturers typically list efficiencies only of certain compressor-coil combinations.</p> <p>Heat pumps may be either split system or single packaged units as defined above under <i>Air Conditioner</i>.</p> <p>See also <i>HSPF (Heating Seasonal Performance Factor)</i>.</p>

*Heating,
Ventilating and Air
Conditioning
(HVAC)*

The mechanical heating, ventilating and air conditioning system of the building is also known as the HVAC system. The standards use various measures of equipment efficiency defined according to the type of equipment installed.

Gas (fossil fuel) heating equipment is rated according to its Annual Fuel Utilization Efficiency (AFUE). The heating efficiency of electric heat pumps with less than 65,000 Btu/h cooling capacity is rated according to Heating Seasonal Performance Factor (HSPF). The heating efficiency of heat pumps with cooling capacity of 65,000 Btu/h or more is rated according to Coefficient of Performance (COP). Electric resistance heating is rated according to its HSPF.

All electric cooling with less than 65,000 Btu/h output capacity is rated according to the Seasonal Energy Efficiency Ratio (SEER). Electric cooling with an output capacity of 65,000 Btu/h or more is rated according to its Energy Efficiency Ratio (EER). (Heat pump cooling is rated according to its SEER or EER, and heat pump heating by the HSPF or COP).

Since few residential buildings use air conditioners or heat pumps with an output capacity greater than 65,000 Btu/h, the Low-Rise Residential Standards only use SEER and HSPF ratings, not EER or COP.

Air Conditioners

See *Air Conditioner* in this Glossary.

Certification

Commission regulations specify that: "Any appliance for which there is a California standard established in the Appliance Efficiency Regulations may be installed only if the manufacturer has certified to the Commission, as specified in those regulations, that the appliance complies with the applicable standard for that appliance." [§111]

HVAC equipment subject to certification includes:

- Room air conditioners
- Central air conditioners with a cooling capacity less than 135,000 Btu/hr
- Central air conditioning heat pumps
- Fan type central furnaces with input rate less than 400,000 Btu per hour
- Boilers
- Wall furnaces
- Floor furnaces
- Room heaters
- Unit heaters
- Duct furnaces

The following types of gas space heaters do not need to be certified:

- Gravity type central furnaces
- Heaters installed in mobile homes at the time of construction
- Heaters designed expressly for use in recreational vehicles and other mobile equipment
- Fan type central furnaces with input rates of at least 400,000 Btu per hour
- Infrared heaters

See §110 and the *Appliance Efficiency Regulations* for further information concerning certification and efficiency requirements for appliances, including refrigerators, water heaters, plumbing fittings and fluorescent lamp ballasts. Directories of certified heating and cooling systems can be accessed or obtained according to information provided in Appendix E. Equipment efficiencies and other specifications listed in the directories can also be obtained by contacting the Commission Energy Hotline (see Chapter 1) or from the Commission's website at <http://www.energy.ca.gov/efficiency/appliances/index.html>.

The term certification is also used in other ways in the standards. Many of the compliance forms are certificates, whereby installers, HERS testers and others certify that equipment was correctly installed and/or tested.

Combined Hydronic Space and Water Heating	For a discussion of combined hydronic space and water heating, see Chapter 5 and Chapter 8.
Duct Losses	The mandatory minimum insulation R-value for ducts that carry conditioned air (heated or cooled) through conditioned space is R-4.2, unless the <i>Uniform Mechanical Code</i> requires a higher insulation level. Chapters 2, 3, and 4 have complete information on duct construction and mandatory duct requirements. The mandatory measures require that ducts be sealed and Package D requires that ducts be diagnostically tested. It is not necessary to test ducts if the performance method is used, but a lower duct efficiency is assumed for the proposed building (see Chapter 5). See Chapter 4 for diagnostic testing and verification of duct performance.
Efficiency Conversions	When equipment is not tested for SEER, the EER may be used as the SEER. When heat pump equipment is not tested for HSPF, the following conversions may be assumed: Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed) Central air conditioning heat pumps, HSPF = (3.2 x COP) - 2.4
Electric Resistance Heating	See <i>Electric Resistance Heating</i> in this Glossary.
Gas Furnaces, Room Heaters and Boilers	Heating systems that utilize natural gas, liquefied petroleum gas or oil are rated by the Energy Commission according to their Annual Fuel Utilization Efficiency (AFUE) .
Heat Pump	See <i>Heat Pump</i> in this Glossary.
Packaged Air Conditioner	A packaged air conditioner combines both condenser and air handling capabilities in a single packaged unit.
Split System Air Conditioner	A split system air conditioner has physically separate condenser and air handling units that work together as a single cooling system.
Wood Heater	Wood heaters and the compliance guidelines and installation criteria are in Chapter 8.
Zonal Control	See <i>Zonal Control</i> in this Glossary, and criteria for obtaining credit for such systems is explained in Chapter 8.
<i>High-Rise Residential</i>	A high-rise residential building is "a building, other than a hotel/motel, of occupancy group R-1 with four or more habitable stories." [§101] All hotels and motels, regardless of the number of stories, and multi-family residential buildings with four or more habitable stories must comply with § 120 through 149 of the standards (Nonresidential and High-Rise Residential Standards), rather than §150 through 152 (Low-Rise Residential Standards).
<i>HSPF (Heating Seasonal Performance Factor)</i>	The Heating Seasonal Performance Factor (HSPF) is "the total heating output of a heat pump (in British thermal units) during its normal usage period for heating divided by the total electrical energy input (in watt-hours) during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations." [§101] HSPF is the heating efficiency measure used for heat pumps and electric furnaces under the current standards. Derived from laboratory tests mandated by the U.S. Department of Energy, the HSPF predicts the Btu of heat output for each watt-hour of input electricity for an average U.S. climate.

HSPF is a rating designed to allow the consumer to easily compare one heat pump with another on the basis of nominal efficiency and, as such, is a reasonable predictor of relative performance.

All air-cooled central air conditioning heat pumps manufactured on or after January 1, 1992 must have the HSPF values listed below:

Appliance		HSPF
Central Air Source Heat Pumps up to 65,000 Btu/h:	Split System	6.8
	Single Package	6.6

For equipment that is not tested for HSPF, the following conversions may be assumed:

Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed)

Central air conditioning heat pumps that do not have an HSPF rating for heating but have a COP rating, $HSPF = (3.2 \times COP) - 2.4$

See *Heating, Ventilating and Air Conditioning and Coefficient of Performance (COP)*.

HVAC

See *Heating, Ventilating and Air Conditioning*.

Hydronic Space Heating

A hydronic space heating system uses water-heating equipment, such as a storage tank water heater or a boiler, to provide space heating. Hydronic space heating includes both radiant floor systems and convective or fan coil systems. The method for analyzing hydronic space heating systems is explained in Chapter 5 and Chapter 8.

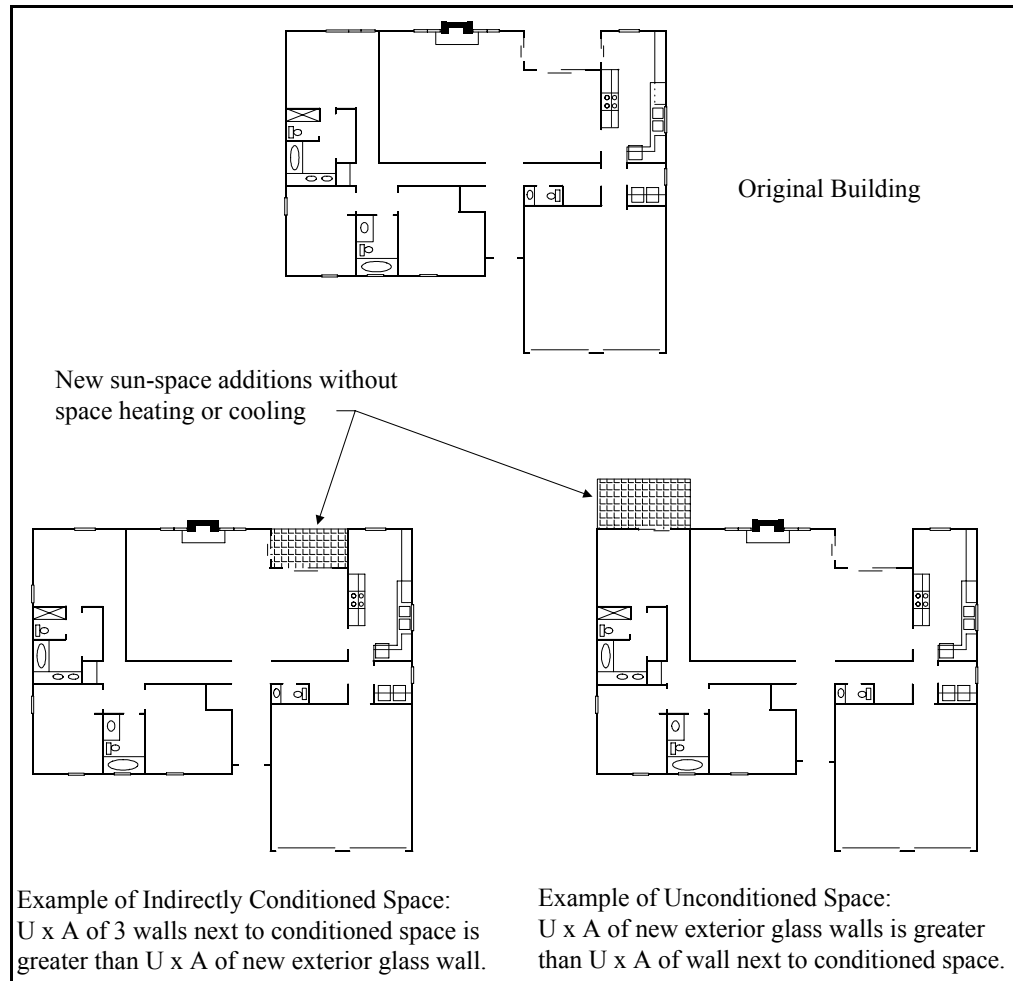
See also *Combined Hydronic Space/Water Heating*.

Indirectly Conditioned Space

"Indirectly conditioned space is enclosed space including, but not limited to, unconditioned volume in atria, that (1) is not directly conditioned space; and (2) either (a) has an area-weighted heat transfer coefficient to directly conditioned space exceeding that to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding 3 air changes per hour." [§101]

Indirectly conditioned space must be included when calculating total conditioned floor area. Examples of areas that *may* be indirectly conditioned space include enclosed porches, enclosed sunrooms, laundry rooms and furnace closets. See Figure G-6 for an example.

Figure G-6:
Unconditioned vs.
Indirectly
Conditioned



Infiltration

"Infiltration is uncontrolled inward air leakage from outside a building, or unconditioned space, including leakage through cracks and interstices, around windows and doors, and through any other exterior or demising partition or pipe or duct penetration." [§101]

Infiltration Controls

Infiltration of air can be controlled in various ways, many of which are mandatory measures and therefore considered "standard" in new residential construction. Mandatory Infiltration control measures include weatherstripping, caulking and sealing in and around all exterior joints and openings as explained in Chapter 2.

See Chapter 4 for diagnostically measured infiltration reduction in the performance approach.

Insulation

Insulating material of the types and forms listed in 118(a) of the standards (Chapter 2) "may be installed only if the manufacturer has certified that the insulation complies with the California Quality Standards for Insulating Material, Title 20, Chapter 4, Article 3." [§118(a)]

Insulation must be placed within or contiguous with a wall, ceiling or floor, or over the surface of any appliance or its intake or outtake mechanism for the purpose of reducing heat transfer or reducing adverse temperature fluctuations of the building, room or appliance.

Insulation may be installed in wall, ceiling/roof and raised floor assemblies and at the edge of a slab-on-grade. Movable insulation is designed to cover windows and other glazed openings part of the time to reduce heat loss and heat gain.

Insulation R-Value

The R-value of insulation or any material or building component is the measure of its thermal resistance expressed in ft²-hr-°F/Btu (see R-Value). This value may be obtained from Appendix B or from manufacturer's literature.

The rated R-value of mineral fiber (batt) insulation is based upon its fully expanded thickness. When the insulation is compressed, the R-value is reduced. For example, an R-19 batt of insulation expands to a thickness of 6 inches. If it is compressed into 2x6 framing with an actual depth of 5.5 inches, the insulation R-Value is lowered to R-17.8. See Table G-5 for some common compressed insulation values.

Table G-5: R-Values for Mineral Fiber Batt Insulation¹

Standard R-Value	Nominal Lumber Size	Actual Cavity Depth	Compressed R-Value
13 (3.625")	2x4	3.5"	13
19 (6.25")	2x6	5.5"	17.8
22 (6.75")	2x6	5.5"	20
30 (9.5") ²	2x10	9.25"	30
38 (12") ²	2x12	11.25"	37

1. Based on manufacturer's data.

2. Note that batt insulation with these R-values is available in smaller thicknesses. R-30 may be achieved with an 8.25" to 8.5" batt, and R-38 may be achieved with a 10.25" to 10.5" batt. If this thinner insulation is used in the framing sizes listed here, the insulation would retain its full rated R-value because it would not be compressed.

Interior Partition

An interior wall or floor/ceiling that separates one area of conditioned space from another within the building envelope.

Knee Wall

A knee wall is a sidewall separating conditioned space from attic space under a pitched roof. Knee walls should be insulated as an exterior wall as specified by the chosen method of compliance.

Left

"Left" indicates the left side of the building as one faces the front facade from the outside (see Front).

This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Left-East). See also *West-Facing*, etc.

Lighting

The low-rise residential standards have mandatory measures for kitchen and bathroom lighting, and for incandescent lighting fixtures recessed into insulated ceilings [§150(k)].

Both kitchens and rooms containing a bathtub or shower are required to have at least one luminaire with lamps that have an efficacy of at least 40 lumens per watt. For kitchens, this luminaire must be used for general lighting (see General Lighting). For bathrooms, the standards allow an alternative to the requirement by (1) installing the 40 lumens per watt fixture in a utility room, laundry room, or garage, and (2) installing 40 lumens per watt fixtures in all permanently mounted outside fixtures or equipping the fixture with a motion sensor.

Fluorescent lamps are generally used to meet these requirements. Screw-in compact fluorescents do not qualify, since they are used with medium base incandescent lamp sockets. Hard-wired compact fluorescents where the ballast is part of the luminaire and that have an efficacy of at least 40 lumens per watt do meet these requirements.

See Chapter 2 for a complete explanation of all the mandatory lighting requirements, including installation criteria.

Liquid Line

The refrigerant line that leads from the condenser to the evaporator in a split system air conditioner or heat pump. The refrigerant is in a liquid state and is at an elevated temperature. This line should not be insulated.

Low-Rise Residential

Any building of occupancy group R, excluding all hotels, all motels and apartment buildings with four or more habitable stories.

<i>Lumens/Watt</i>	A lumen is a measure of the amount of light available from a given light source. A watt is a measure of the power requirement for that light source. The efficacy of a light source is measured by dividing the lumens by the wattage. The more usable light that a light source provides per watt, the greater its energy efficiency.
<i>Manufactured Device</i>	A manufactured device is "any heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, plumbing fitting, insulation, door, fenestration product, or any other appliance, device, equipment or system subject to § 110 through §119 of Title 24 Part 6." [§101]
<i>Mixed Occupancy</i>	A building designed and constructed for more than one type of occupancy, such as a three story building with ground floor retail and second and third floor residential apartments (see Chapter 8).
<i>Multi-Family</i>	A dwelling unit of occupancy type R, as defined by the <i>UBC</i> , sharing a common wall and/or ceiling/floor with at least one other dwelling unit (see Chapter 8). See also <i>Building Types</i> .
<i>NFRC</i>	<p>The National Fenestration Rating Council. A national organization of manufacturers of fenestration products, glazing and related materials, plus utilities, state energy offices, laboratories, home builders, specifiers (architects) and public interest groups.</p> <p>This organization is responsible for rating the U-factors and solar heat gain coefficient of manufactured fenestration products (i.e., windows, skylights, glazed doors) that must be used in compliance calculations. All manufactured fenestration products must be labeled with NFRC rated values or with the default U-factors listed in Table G-4 for compliance with the standards (see also Chapter 2 and Chapter 8).</p> <p>See also <i>Fenestration Area</i> and <i>Fenestration Product</i>.</p>
<i>North-Facing</i>	<p>"North-facing is oriented to within 45 degrees of true north, including 45°0'0" east of north (NE), but excluding 45°0'0" west of north (NW)." [§101]</p> <p>This definition applies only to the prescriptive packages and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.</p>
<i>Outside Air</i>	"Outdoor air (Outside air) is air taken from outdoors and not previously circulated in the building." [§101]
<i>Proposed Design</i>	The proposed building design which must comply with the standards before receiving a building permit. See also <i>Energy Budget</i> and <i>Standard Design</i> .
<i>Radiant Barriers</i>	Radiant barriers are shiny metallic surfaces that are applied to the roof of the attic and its end walls. In attics, the radiant barrier is typically installed on the underside of the attic roof. Often the radiant barrier is pre-applied to the structural deck of the attic roof. To qualify under the standards, a radiant barrier must have an emittance less than 0.05 and be certified by the Bureau of Home Furnishings. Radiant barriers reduce the temperature of the attic and solar heat gain through the ceiling. This reduces air conditioning energy, both because the cooling load is lower and because the effectiveness of air distribution ducts is improved. Requirements for radiant barriers are contained in Chapters 2 and 3.
<i>Raised Floor</i>	<p>A "raised floor is a floor (partition) over a crawl space, or an unconditioned space, or ambient air." [§101]</p> <p>See Chapters 3 and 5, and the Glossary definition of <i>Conditioned Footprint Area</i>.</p>
<i>Readily Accessible</i>	"Readily accessible is capable of being reached quickly for operation, repair, or inspection, without requiring climbing or removing obstacles, or resorting to access equipment." [§101]
<i>Rear</i>	See <i>Back</i> .

<i>Recovered Energy</i>	<p>"Recovered energy is energy used in a building that (1) is mechanically recovered from space conditioning, service water heating, lighting or process equipment after the energy has performed its original function; (2) provides space conditioning, service water heating or lighting; and (3) would otherwise be wasted." [§101]</p> <p>An air-to-air heat exchanger is an example of a system that recovers energy of this kind.</p>
<i>Recovery Efficiency</i>	<p>Recovery efficiency is one measure of the efficiency of water heaters. It is required for water heating energy calculations for some types of water heaters (see Chapter 6). It is "a measure of the percentage of heat from combustion of gas or oil which is transferred to the water. For non-storage type water heaters, the recovery efficiency is really a thermal efficiency." [AER, Section 1602]</p>
<i>Refrigerant Charge</i>	<p>The term "refrigerant charge" refers to the amount of refrigerant that is installed or "charged" into an air conditioner or heat pump. The refrigerant is the working fluid in an air conditioner or heat pump. It is compressed and becomes a liquid as it enters the condenser. The hot liquid is cooled in the condenser and flows to the evaporator where it is released through the expansion valve. When the pressure is released, the refrigerant expands into a gas and cools. Air is passed over the evaporator to provide the space cooling. When an air conditioner or heat pump has too much refrigerant (overcharged) the compressor may be damaged. When an air conditioner has too little refrigerant (undercharged), the efficiency of the unit is reduced. A thermostatic expansion valve (TXV) can mitigate the impact of improper refrigerant charge.</p> <p>The standards require that split system air conditioners and split system heat pumps be tested in the field by a certified HERS rater to verify that the system has the correct charge and airflow.</p>
<i>Repair</i>	<p>"Repair is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. Note: Repairs to low-rise residential buildings are not within the scope of these standards." [§101]</p>
<i>Right</i>	<p>"Right" indicates the right side of the building as one faces the front facade from the outside (see <i>Front</i>). This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Right-West). See also <i>North-Facing</i>, <i>East-Facing</i>, etc.</p>
<i>Roof</i>	<p>See <i>Exterior Roof/Ceiling</i>.</p>
<i>R-Value (Thermal Resistance)</i>	<p>The R-value of a material is "the [thermal] resistance of a material or building component to the passage of heat in (hr-ft²-°F)/Btu." [§101]</p> <p>The R-value indicates how well a material prevents heat from flowing through it. R-19 insulation, for example, is only half as effective at slowing heat transfer as R-38 insulation.</p> <p>When more than one material is put in series with another in a construction assembly (such as exterior siding, insulation and interior gypsum board), the thermal resistance of the assembly is equal to the sum of the individual resistances (see Figures G-7 and G-8).</p>

NOTE:

For heat flow through a series of layers adding the U-factors of the individual layers of an assembly does not produce the total U-factor. Thermal resistances (R-values) must first be added and the total resistance (R_{Total}) divided into 1 to yield the correct U-factor.

Correct:

$$U = \frac{1}{R_1 + R_2 + R_3 + \dots + R_n} = \frac{1}{R_{\text{Total}}}$$

Incorrect:

$$U = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n} = U_1 + U_2 + U_3 + \dots + U_n$$

The U-factor is the heat transfer coefficient expressed in Btu/ft²-hr-°F, the rate at which heat flows through an assembly or material.

The total R-value should be calculated to two decimal places, and the total U-factor to three decimal places.

Default R-values/U-factors in Appendix H

Appendix H contains pre-calculated Form 3Rs for a number of standard assemblies. The Total R-values and U-factors from these assemblies must be used in compliance calculations unless a Form 3R is completed for the actual proposed assembly, or unless the compliance approach only uses the insulation level alone. Tables G-14 through G-18 summarize these default U-factors.

Appendix H also includes Form 3Rs for assemblies that meet the default U-factors with a combination of batt and rigid insulation, rather than only batt insulation (including metal frame assemblies). In addition, it contains R-values and other information on a variety of masonry wall assemblies.

To determine if an assembly meets the minimum insulation levels required by the mandatory measures or the prescriptive packages, obtain the U-factor of the proposed assembly or complete a Form 3R for a wood frame assembly and see if the proposed U-factor is less than or equal to the standard U-factor for that assembly type and insulation level as listed in Tables G-14 through G-17. Compare the proposed U-factor to the U-factors listed for framing spacing of 16" o.c. for walls and 24" o.c. for roofs/ ceilings.

How to Complete Form 3r

The U-factor and R-value of a proposed construction assembly is calculated on Form 3R (a blank copy of Form 3R is contained in Appendix A). The form is used in documenting compliance and design load calculations (see *Compliance Documentation*).

Form 3R uses the parallel path method for determining the overall U-factor of wood framed assemblies. This entails calculating the total R-value of the assembly through both the cavity between framing and through the frame material itself, and then calculating the area-weighted U-factor for the assembly overall.

NOTE:

U-factors for metal frame walls are not calculated using the parallel path method, but instead are determined using a method based on the zonal method in the 1993 *ASHRAE Handbook of Fundamentals* or manufacturers' data (see Appendix H or Chapter 2 for more information). Pre-calculated default U-factors for metal frame walls may also be used in compliance calculations. These are listed in Table G-18.

Figures G-7 and G-8 are examples of completed Form 3Rs. The general steps for completing a Form 3R are listed below:

Parallel Path Method

1. List the Assembly *Name* (e.g., "Flat Ceiling"), Assembly *Type* (e.g., Wall, Roof, Floor), Framing *Material* (e.g., Wood or Metal), Framing *Size* (e.g., 2x6), Framing *Spacing* (e.g., 16" o.c.) and Framing % (from Table G-6). If a prescriptive package is being used to show compliance and the assembly is a wall, list the wall weight per square foot.
2. Identify the appropriate R-values for Outside and Inside Air Films according to the standard values listed in Table G-7 for winter conditions. An inside film may be assumed on both sides of the assembly when the heated space is adjacent to an enclosed, unconditioned space. List these numbers in both the Cavity R-Value and Frame R-Value columns of Form 3R.

IMPORTANT NOTE:

Do not round any of the values used on Form 3R except for the final resulting Total R-Value shown in Step 7 below.

Air film R-values may also be taken from ASHRAE Table 1, Surface Conductances for Air, in Appendix B. The STILL AIR value is the inside film and the MOVING AIR value is the outside film.

- Starting with the outside material, identify the type and thickness of each construction assembly component, including air spaces (see *Attic and Crawlspace R-values* below), and list them on successive lines under "List of Construction Components."

Table G-6:
Framing
Percentages

Assembly Type	Framing Spacing	Framing Percentage
Walls	16"o.c.	15 %
	24"o.c.	12 %
	48"o.c.	9 %
Floors	16"o.c.	10 %
	24"o.c.	7 %
Roofs	16"o.c.	10 %
	24"o.c.	7 %
	48"o.c.	4 %

- For each component, find the associated Resistance (R) from ASHRAE Table 2, Thermal Resistance of Plane Air Spaces, and Table 4, Thermal Properties of Typical Building and Insulating Materials - Design Values, found in Appendix B. **When a range of ASHRAE values is listed for a material, use the most conservative assumption for compliance with the standards** (i.e., the lowest R-value or the highest U-factor). Typical R-values for unframed air spaces are listed in Table G-7. Manufacturers' rated R-values may be used in lieu of ASHRAE values. For insulation or air spaces penetrated by wood framing, both the insulation or air space and the framing itself should be listed.

Table G-7:
Standard R-
Values for Air
Films and Air
Spaces¹

Air Films ²	Wall	Roof Flat ³	Roof 45° angle ⁴	Floor
Inside	0.68	0.61	0.62	0.92
Outside	0.17	0.17	0.17	0.17
Air Spaces⁵				
0.5 inch	0.77	0.73	0.76	0.77
0.75 inch	0.84	0.75	0.81	0.85
1.5 inch	0.87	0.77	0.80	0.94
2.0 inch	0.875	0.778	0.805	0.955
2.5 inch	0.86	0.785	0.81	0.97
3.5 inch ⁶	0.85	0.80	0.82	1.00

1. Values from ASHRAE Handbook of Fundamentals, 1993 edition, Chapter 22, Tables 1, 2 and 3 reprinted in Appendix B of this manual.

2. Assumes a non-reflective surface emittance of 0.90 and winter heat flow direction.

3. Use the "Flat" roof R-values for roof angles between horizontal and 22 degrees.

4. Use the "45 degree" roof R-values for roof angles between 23 and 60 degrees.

5. Assumes mean temperature of 90°F, temperature difference of 10°F, surface emittance of 0.82 and winter heat flow direction.

6. Use these R-values for air spaces greater than or equal to 3.5 inches, such as attics.

Figure G-7: Form
3R Roof/Ceiling
Assembly

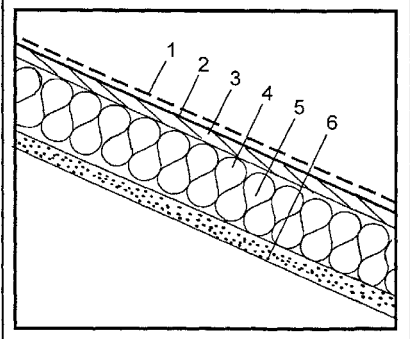
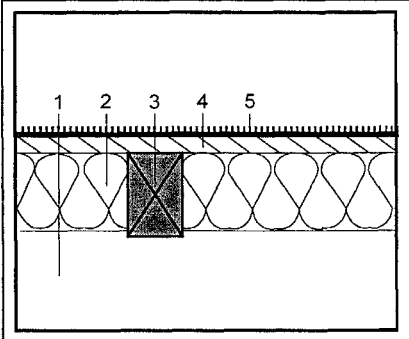
PROPOSED CONSTRUCTION ASSEMBLY: RESIDENTIAL		FORM 3R
Project Title <u>Smith Residence</u>		Date <u>July 1, 1999</u>
Project Address <u>123 Main Street, Sacramento, CA</u>		<div style="border: 1px solid black; padding: 2px;"> Building Permit # _____ Plan Check / Date _____ Field Check / Date _____ Enforcement Agency Use Only </div>
Documentation Author <u>Mary Jones</u>		
Telephone <u>(916) 555-0000</u>		
Assembly Name <u>R-30 Roof</u>		
 <p style="text-align: center; font-size: small;">Sketch of Proposed Construction Assembly</p>	Assembly Type: (check one) <input type="checkbox"/> Floor <input type="checkbox"/> Wall <input checked="" type="checkbox"/> Ceiling/Roof	
Framing Material: <u>Wood</u> Framing Size: <u>2</u> x <u>10</u> Framing Spacing: <u>16</u> inches on center (" o.c.) Framing Percentage (Fr.%): (check one) <div style="display: flex; justify-content: space-between;"> <div> Wall: <input type="checkbox"/> 15% (16" o.c.) <input type="checkbox"/> 12% (24" o.c.) <input type="checkbox"/> 9% (48" o.c.) Floor/Ceiling: <input checked="" type="checkbox"/> 10% (16" o.c.) <input type="checkbox"/> 7% (24" o.c.) <input type="checkbox"/> 4% (48" o.c.) </div> <div> Wall Weight / sf: <u>N/A</u> (Packages only) </div> </div>		
List of Construction Components		
Outside Surface Air Film		R-Value
1. <u>Asphalt shingle roofing</u>	Cavity (R _c) <u>0.170</u>	Frame (R _f) <u>0.170</u>
2. <u>Building paper (felt)</u>	<u>0.440</u>	<u>0.440</u>
3. <u>0.50 in plywood</u>	<u>0.060</u>	<u>0.060</u>
4. <u>2x10 in fir framing</u>	<u>0.620</u>	<u>0.620</u>
5. <u>R-30c fiberglass insulation (8.5" thkns)</u>	<u>30.000</u>	<u>9.158</u>
6. <u>0.50 in gypsum or plaster board</u>	<u>0.450</u>	<u>0.450</u>
7. _____	_____	_____
8. _____	_____	_____
Inside Surface Air Film		<u>0.610</u>
Total Unadjusted R-Values:		<u>32.350</u>
		R _c
		<u>11.508</u>
		R _f
Framing Adjustment Calculation:		
$\left[\frac{1}{1 + R_c} \times \left(\frac{1 - 10/100}{1 - (Fr.\% + 100)} \right) \right] + \left[\frac{1}{1 + R_f} \times \left(\frac{10/100}{Fr.\% + 100} \right) \right] = \frac{0.036}{\text{Total U-Value}}$		
$\frac{1}{0.036} = \frac{27.778}{\text{Total R-Value}}$		
July 1, 1999		

Figure G-8: Form
3R Floor
Assembly

PROPOSED CONSTRUCTION ASSEMBLY: RESIDENTIAL		FORM 3R
Project Title <u>Smith Residence</u>	Date <u>July 1, 1999</u>	
Project Address <u>123 Main Street, Sacramento, CA</u>	Building Permit # <div style="border: 1px solid black; height: 15px; width: 100%;"></div>	
Documentation Author <u>Mary Jones</u>	Telephone <u>(916) 555-0000</u>	
Assembly Name <u>R-19 Raised Floor</u>	Plan Check / Date <div style="border: 1px solid black; height: 15px; width: 100%;"></div>	
Field Check / Date <div style="border: 1px solid black; height: 15px; width: 100%;"></div>		
Enforcement Agency Use Only		



Sketch of Proposed Construction Assembly

Assembly Type: (check one)
☒ Floor
☐ Wall
☐ Ceiling/Roof

Framing Material: Wood

Framing Size: 2 x 8

Framing Spacing: 16 inches on center (" o.c.)

Framing Percentage (Fr.%) (check one)
 Wall: ☐ 15% (16" o.c.)
☐ 12% (24" o.c.)
☐ 9% (48" o.c.)
 Floor/Ceiling: ☒ 10% (16" o.c.)
☐ 7% (24" o.c.)
☐ 4% (48" o.c.)

Wall Weight / sf: NA
 (Packages only)

List of Construction Components		R-Value	
		Cavity (R _c)	Frame (R _f)
Outside Surface Air Film		0.170	0.170
1. <u>Effective R-value of vented crawlspace</u>		6.000	6.000
2. <u>R-19 fiberglass insulation</u>		19.000	—
3. <u>7.25 in fir framing</u>		—	7.178
4. <u>0.625 in plywood</u>		0.770	0.770
5. <u>Carpet & Pad</u>		2.080	2.080
6. _____			
7. _____			
8. _____			
Inside Surface Air Film		0.920	0.920
Total Unadjusted R-Values:		28.940	17.118
		R _c	R _f

Framing Adjustment Calculation:

$$\left[\frac{1}{1 + R_c} \times \left(\frac{1 - 19/100}{1 - (Fr.\% + 100)} \right) \right] + \left[\frac{1}{1 + R_f} \times \left(\frac{10/100}{Fr.\% + 100} \right) \right] = \frac{0.037}{\text{Total U-Value}}$$

$$\frac{1}{1 + 0.037} = \frac{27.027}{\text{Total R-Value}}$$

July 1, 1999

NOTE:

Any carpet and pad combination must be assigned an R-value of R-2.0. Do not use ASHRAE R-values for carpet and pad.

5. List the insulation R-value for batt insulation in the Cavity (R_C) column and the R-value of the wood framing in the Frame (R_f) column. The R-values of all other components (not penetrated by the framing) should be listed in both columns.
6. Add up the R-values in the Cavity (R_C) column and in the Frame (R_f) column. Enter these as the "Total Unadjusted R-Values."
7. Calculate the following values and enter the results in the "Framing Adjustment Calculation":
 - $1/R_C$
 - $1 - (\text{Framing \%}/100)$
 - $1/R_f$
 - $\text{Framing \%}/100$

Complete the arithmetic to obtain the "Total U-factor". Round the Total U-factor to three significant digits (i.e., 0.06554 rounds to 0.066). Then divide 1 by the Total U-factor to obtain the Total R-Value. Round the Total R-Value to two significant digits.

Attic and Crawl Space R-Values

Attic air spaces greater than or equal to 3.5 inches shall be treated as standard 3.5 inch air spaces in a roof assembly. The appropriate R-values for flat and 45 degree roofs are listed in Table G-7. The "Flat" R-value should be used for roof angles between horizontal and 22 degrees, while the "45 degree" R-value applies to roof angles between 23 and 60 degrees. See also Figure G-7 for an example of an attic air space.

Vented crawl spaces shall be assigned a fixed R-value of R-6. See Figure G-8 for an example of a vented crawl space.

Simplified Masonry U-factor Calculation in Appendix I

Appendix I contains an alternative, simplified approach to determine R-values, U-factors and heat capacities for masonry and concrete walls. See Appendix I for details and instructions.

See also *Insulation R-Value* and *U-factor*.

SEER (Seasonal Energy Efficiency Ratio)

The total cooling of a central air conditioner or heat pump in Btu during 12 months divided by the total electric energy input in watt-hours during the same period.

The Seasonal Energy Efficiency Ratio of all new central air conditioners and central air source heat pumps with output less than 65,000 Btu/h manufactured on or after January 1, 1993 shall be certified not to be less than the values listed as follows:

<i>Appliance</i>	<i>Type</i>	<i>SEER</i>
Central Air Conditioners	Split System	10.0
	Single Package	9.7
Central Air Source Heat Pumps	Split System	10.0
	Single Package	9.7

See also *Heating, Ventilating and Air Conditioning*, and *EER*.

Service Water Heating

"Service water heating is heating of water for sanitary purposes for human occupancy, other than for comfort heating." [§101]

Shading

The effectiveness of a fenestration product plus shade assembly in stopping heat gain from solar radiation is expressed as the Solar Heat Gain Coefficient (SHGC). SHGC values range from 0 to almost 1. The more effective at stopping heat gain, the lower the SHGC value. See also *Solar Heat Gain Coefficient*.

See Tables G-8 G-9, and G-10 for allowed SHGCs.

Shading Coefficient (SC)

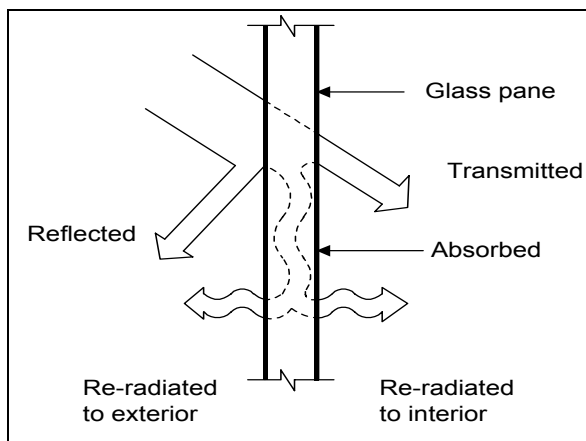
See *Shading, Solar Heat Gain Coefficient*.

Solar Heat Gain Coefficient (SHGC)

“Solar heat gain coefficient (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.” [§101]

Controlling heat gain from solar radiation is an integral element of the standards and therefore must be taken into account for compliance purposes. Solar Heat Gain Coefficient (SHGC) replaces the Shading Coefficient (SC) used in earlier versions of the standards as a measure of the solar heat gain due to windows and shading devices.

Figure G-9: Solar Radiation through Glass



For compliance purposes, SHGC is determined from the default table and based on glass type and framing (see Table G-8). However, the preferred method is to use data from the NFRC label.

Internal shading devices are modeled in compliance calculations for windows, but the same device is assumed for both the proposed and budget buildings, so there is no compliance credit for internal devices. Internal shading is not modeled for skylights, either for the proposed or budget buildings. See Table G-9.

Approved computer programs calculate the SHGC of a window with the default interior *shade open* and *shade closed*. Generally, glazing is assumed to be unshaded (Shade Open) during the winter period when solar gains can contribute to building energy needs and shaded (Shade Closed) during the summer period when solar gains are undesirable. However, these values are not reported to the user.

Table G-8:
Default Solar Heat
Gain Coefficient --
Total Window
SHGC

(Table 1-E from §116)

Frame Type	Product	Glazing	Single Pane	Double Pane
Metal	Operable	Clear	0.80	0.70
Metal	Fixed	Clear	0.83	0.73
Metal	Operable	Tinted	0.67	0.59
Metal	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Clear	0.72	0.63
Metal, Thermal Break	Fixed	Clear	0.78	0.69
Metal, Thermal Break	Operable	Tinted	0.60	0.53
Metal, Thermal Break	Fixed	Tinted	0.65	0.57
Non-Metal	Operable	Clear	0.74	0.65
Non-Metal	Fixed	Clear	0.76	0.67
Non-Metal	Operable	Tinted	0.60	0.53
Non-Metal	Fixed	Tinted	0.63	0.55

SHGC = Solar Heat Gain Coefficient

Table G-9:
SHGC's for
Allowed Interior
Shading
Attachments

Interior Shading Attachment/Device¹	SHGC
Standard includes Draperies (all colors & weaves), None (for non-skylights), or Translucent Roller Shades (all colors) Standard values are also used for any interior shading device not otherwise listed in this table	0.68
None Only Allowed for Skylights. Also the default value for skylights when no other interior shading is specified.	1.00

¹ Shading devices between glazing lights for vertical windows or skylights may be modeled as a default interior shade.

External Shading Devices

If using a prescriptive alternative component package for compliance, use values from Table G-10 or data from the NFRC label. If an exterior shading device is planned, the SHGC may be calculated using the *Solar Heat Gain Coefficient (SHGC) Worksheet* (Form S). The *Solar Heat Gain Coefficient Worksheet* incorporates the following basic formula for calculating a combined SHGC:

$$SHGC_{comb} = [(0.2875 \times SHGC_{max}) + 0.75] \times SHGC_{min}$$

Where:

$SHGC_{comb}$ = Combined solar heat gain coefficient

$SHGC_{max}$ = Maximum solar heat gain coefficient

$SHGC_{min}$ = Minimum solar heat gain coefficient

The *Solar Heat Gain Coefficient Worksheet* allows the calculation of SHGC for both simple and complex shade combinations.

Instructions for Form S

The following sections explain how to calculate solar heat gain coefficients Form S. The number of each item below corresponds to the appropriate item on Form S.

Enter either:

1a. For products with NFRC testing and labels, enter the product's labeled SHGC as
#1a. $SHGC_{fen}$.

OR enter

- 1b. The default $SHGC_{fen}$ from Table G-8 corresponding to the fenestration characteristics described in entries 1c, 1d, 1e, and 1f. Entries for 1c, 1d, 1e, and 1f are only needed if 1b is entered for $SHGC_{fen}$.

If 1b. is entered then:

- 1c. Describe the Frame Type [metal, metal w/thermal break, or non-metal (non-metal includes both vinyl and wood)].
- 1d. The Product Type (operable or fixed);
- 1e. The Glazing Type (tinted or uncoated); Note that tints or coatings that cannot be easily observed by the building official must be classified as “uncoated”, that is, tints must be easily visible to the naked eye.
- 1f. Single or Double pane glazing.
2. For skylights mounted on a roof surface, enter “Y”, other wise enter “N.” A skylight is fenestration mounted at a slope less than 60 degrees from the horizon.

In a performance compliance, select *Standard* or *Draperies* . Since, this is the only available choice and some compliance tools will eliminate this choice altogether.

Complete steps 3 through 4 for any exterior shades.

Exterior Shade

Complete steps 1 and 2 for the fenestration product. Using these values, continue with steps 3 and 4.

3. Describe the exterior shading device in the space provided (e.g., roll down awning). List $SHGC_{Exterior\ Shade}$, the SHGC of the exterior shade with 1/8" clear single pane glass and metal framing, from Table S-2 (attached to Form S in Appendix A) or G-10. If a single window or skylight has multiple exterior shades (i.e. shade screens and awnings) use the one shading device with the lower SHGC.
- If no exterior shade is proposed, assume standard bug screens with a SHGC of 0.76 (or an SHGC of 1.00 for horizontal glazing). This applies to the full area of fixed fenestration products as well as operable.
4. Calculate $SHGC_{Shade\ Open}$ using values from Items 3 and either 1a or 1b. The result is the combined SHGC of the fenestration product and exterior device with the interior *shade open*.

Table G-10: Solar Heat Gain Coefficients Used for Form S and Computer Performance Methods^{1, 2}

Exterior Shading Attachment/Device³	SHGC⁴
1) Standard Bug Screens	0.76
2) Exterior Sunscreens with weave 53*16/inch	0.30
3) Louvered Sunscreens w/louvers as wide as openings	0.27
4) Low Sun Angle (LSA) Louvered Sunscreens	0.13
5) Roll-down Awning	0.13
6) Roll Down Blinds or Slats	0.13
7) None (for skylights only)	1.00

1. These values may be used on line 11 of the Solar Heat Gain Coefficient Worksheet (form S) to calculate exterior shading with other glazing types and combined interior and exterior shading with glazing.

2. Exterior operable awnings (canvas, plastic or metal), except those that roll vertically down and cover the entire window, should be treated as overhangs for purposes of compliance with the Standards.

3. Standard bug screens must be assumed for all fenestration unless replaced by other exterior shade screens. The solar heat gain coefficient listed for bug screens is an area-weighted value that assumes that the screens are only on operable windows. The solar heat gain coefficient of any other exterior shade screens applied only to some window areas must be area-weighted with the solar heat gain coefficient of standard bug screens for all other glazing (see Weighted Averaging in the Glossary). Different shading conditions may also be modeled explicitly in the computer performance method.

4. Reference glass for determining solar heat gain coefficients is 1/8 inch double strength (DSS) glass.

$SHGC_{fen}$ (from either 1a. or 1b.) and the types of interior and exterior shading attachments are used directly on the Certificate of Compliance (CF-1R) for the prescriptive packages.

Overhangs Overhang shading is modeled explicitly in the computer performance method. There are no overhang requirements in the prescriptive packages but credit is offered through the performance approach. Overhang shading may not be included in the SHGCs used to meet the minimum prescriptive requirements; credit is offered only with performance methods.

Shading by Adjacent Structures or Terrain or other Permanent Obstructions Fenestration may be considered *substantially shaded* if a permanent obstruction is substantially wider than the fenestration being considered and if the obstruction is tall enough to shade the top of the fenestration at a profile angle of 45 degrees. If fenestration is substantially shaded in the summer and winter by a permanent obstruction, the glazing may be treated as having a permanently fixed exterior SHGC of 0.20 for compliance calculations.

It is up to the local enforcement agency to determine whether the shading elements are sufficiently permanent and meet the criteria.

Side Fins Vertical shading elements mounted on either side of a glazed opening that can protect the glazing from lateral low angle sun penetration.

Single Family Attached A multi-family building whose dwelling units share common walls but do not share any common floors/ceilings is considered Single Family Attached.

See *Building Types*.

Single Family Building A single dwelling unit of occupancy type R, as defined in the *UBC*, which stands separate and unattached from other dwelling units, but may have an attached garage. A dwelling unit that is separated only by a property line and double wall construction (with a space between the walls) from another dwelling unit and that shares no common floor/ceiling is also treated as single family.

Skylight A skylight is "glazing having a slope less than 60 degrees from the horizontal with conditioned space below." [§101]

See also *Fenestration Product, Glazing*.

Slab-on-Grade	<p>A slab-on-grade is an exterior concrete floor in direct contact with the earth below the building.</p> <p>See Chapters 3 and 5, and the <i>Glossary</i> definitions of <i>Conditioned Footprint Area</i> and <i>Exterior Floor</i>.</p>										
Solar Heat Gain Coefficient (SHGC)	<p>The solar heat gain coefficient is a measure of the effectiveness of a fenestration product or window covering to stop solar gains through the window. Solar heat gain coefficient (SHGC) is the "ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space." [§101]</p> <p>See <i>Shading</i> for information on compliance with the standards.</p>										
Source Energy	<p>Source energy is the original energy consumed to produce usable end-use energy for space conditioning, lighting, appliances and other uses in a building. The standards are based on the concept of an annual energy budget that measures source energy used per year in a building.</p> <p>Source energy accounts for all of the energy used in delivering energy to the building site including power generation, transmission losses and distribution. Electricity (kWh) is converted to source energy (Btu) at the rate of 10,239 Btu per kilowatt-hour (3 times 3,413). This assumes that only a third of the energy used to produce electricity is actually delivered to a building in a usable form.</p> <p>By contrast, fossil fuels such as natural gas, propane and oil may be used directly at the building site, so that source energy equals end-use energy. Natural gas used directly at the building site is converted to source energy at the rate of 100,000 Btu per therm.</p>										
Table G-11: Source Energy Conversion Rates¹	<table> <tr> <th>Energy Source</th><th>Btu per unit consumption</th></tr> <tr> <td>Electricity</td><td>10,239 Btu/kilowatt-hour</td></tr> <tr> <td>Natural Gas</td><td>100,000 Btu/therm</td></tr> <tr> <td>Fuel Oil</td><td>138,400 Btu/gallon</td></tr> <tr> <td>LPG (Propane)</td><td>91,080 Btu/gallon</td></tr> </table> <p>¹ Reprinted from §102, Table 1-B.</p> <p>See <i>Energy Budget, Heating, Ventilating and Air Conditioning (Electric Resistance Heating)</i>.</p>	Energy Source	Btu per unit consumption	Electricity	10,239 Btu/kilowatt-hour	Natural Gas	100,000 Btu/therm	Fuel Oil	138,400 Btu/gallon	LPG (Propane)	91,080 Btu/gallon
Energy Source	Btu per unit consumption										
Electricity	10,239 Btu/kilowatt-hour										
Natural Gas	100,000 Btu/therm										
Fuel Oil	138,400 Btu/gallon										
LPG (Propane)	91,080 Btu/gallon										
South-Facing	<p>"South-facing is oriented to within 45 degrees of true south, including 45°0'0" west of south (SW), but excluding 45°0'0" east of south (SE)." [§101]</p> <p>This definition applies only to the prescriptive packages and master plans analyzed according to the multiple orientation alternative, as explained in Chapter 8. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.</p> <p>The designation "South-Facing" is also used in production buildings using orientation restrictions (e.g., Shaded Areas: East-Facing). See Chapter 8.</p>										
Space Conditioning System	<p>A space conditioning system is "a system that provides . . . heating, ventilating, or cooling within or associated with conditioned spaces in a building." [§101] The system may operate alone or in conjunction with other systems.</p> <p>See <i>Heating, Ventilating and Air Conditioning</i>.</p>										
Stairs	See <i>Conditioned Floor Area</i> .										
Standard Design	A new building or addition alone (see Chapter 7) complies with the standards if the predicted source energy use of the proposed design is the same or less than the annual										

budget for space conditioning and water heating of the standard design. For both slab-on-grade and raised floor buildings, the standard design is based on the conservation levels and features in prescriptive Package D.

See *Source Energy*, *Energy Budget* and *Proposed Design*, and Chapter 5.

<i>Standards</i>	The California <i>Energy Efficiency Standards</i> as set forth in the <i>California Code of Regulations</i> , Title 24, Part 6.
<i>Standby Loss</i>	Standby loss is the ratio of heat lost per hour to the heat content of the stored water above room temperature. It is one of the measures of efficiency of water heaters required for water heating energy calculations for some types of water heaters (see Chapter 6). Standby loss is expressed as a percentage. [AER, Section 1602]
<i>Straw Bales</i>	Straw bales that are 23 inches by 16 inches and that have stucco or plaster on the inside and outside vertical surfaces are assumed to have a thermal resistance of R-30 and a U-factor of 0.033 with framing that penetrates no more than 25 percent of the way through the straw bale. Performance data on other sizes of bales was not available at the time of publication of this <i>Manual</i> .
<i>Subordinate Occupancy</i>	In mixed occupancy buildings, any occupancy type that is not the dominant occupancy. See also <i>Dominant Occupancy</i> , <i>Mixed Occupancy</i> , and Chapter 8.
<i>Suction Line</i>	The refrigerant line that leads from the evaporator to the condenser in a split system air conditioner or heat pump. This line is typically insulated since it carries refrigerant at a low temperature. Pipe insulation requirements are contained in Chapter 2.
<i>System</i>	A system is "a combination of equipment, controls, accessories, interconnecting means, or terminal elements, by which energy is transformed to perform a specific function, such as space conditioning, service water heating, or lighting." [§101]
<i>Task Oriented Lighting</i>	Task lighting is "lighting that is designed specifically to illuminate a task location, and that is generally confined to the task location." [§101] See also <i>Lighting</i> , <i>General Lighting</i> , Chapter 2.
<i>Thermal Mass</i>	"Thermal mass is solid or liquid material used to store heat for later heating use or for reducing cooling requirements." [§101] Commonly used thermal mass materials include concrete, masonry, brick, tile, rock and water. These materials are readily available and have excellent thermal properties. The more mass a building has, the slower its interior temperatures will change. Thermal mass can conserve energy in a residential building in two basic ways: <ul style="list-style-type: none">• In the winter, solar radiation entering a building through glass is absorbed directly or indirectly into areas of thermal mass exposed to indoor air. The mass material tends to store its heat during the day and release it into the room air during the evening and night when more heating is required.

Table G-12:
Thermal Mass
Properties

Material	Conductivity (Btu/ hr-ft²-°F)	Density (lb/ft³)	Specific Heat (Btu/lb-°F)
Adobe	0.33	120	0.20
Heavy Concrete	0.98	140	0.20
Lightweight			
Concrete	0.36	85	0.20
Gypsum	0.09	50	0.26
Masonry Veneer	0.62	127	0.20
Masonry Infill	0.44	120	0.20
Concrete Masonry Unit	0.59	105	0.20
Grouted Concrete Masonry Unit	1.00	134	0.20
Stucco	0.47	105	0.20
Tile in Mortar	0.67	120	0.20
Solid Wood (Fir)	0.07	32	0.33

Table G-13:
Thermal Mass
Coverings and
Associated
Categories¹

Category 1: Acceptable as Exposed Mass In Any Location. Floor coverings/surfaces determined to be acceptable on any portion of a slab designated as thermal mass in any location within the conditioned space of a residential building.	
Category 2: Acceptable as Exposed Mass Only In Kitchens, Dining Areas that are Extensions to Kitchens, Pantries, Bathrooms, Laundry Rooms, Service Porches and/or Entries. Concrete slabs with Category 2 surfaces must be treated as covered slab in other locations.	
Covering/Surface	Category
Brick	1
Concrete, Exposed Aggregate	1
Concrete, Painted and/or Polished	2
Concrete, Stamped	1
Concrete, Unfinished	2
Hardwood Veneer (except when installed on wood sleepers)	1
Resin-based Poured Flooring	2
Stone or Stone Veneer	1
Sheet Vinyl	2
Tile, Asphalt	2
Tile, Ceramic	1
Tile, Terrazzo	1
Tile, Vinyl	2
Tile, Vinyl-Asbestos	2
Other Masonry Materials with Permanent Finishes Similar to Those Specified in Category 1 and Acceptable to the Building Official	1

1. The intent of these guidelines is to prevent taking exposed thermal mass credit for floor materials that are likely to be covered with carpeting at the time of building occupancy.

Building officials should allow flexibility for building designs that include radiant floor heating systems and/or that incorporate large areas of uncarpeted slabs in conjunction with south facing glazing as an integral component of deliberately designed passive solar structures.

- In the summer months, the mass material can be cooled down at night by natural ventilation. During the daytime, the mass absorbs excess heat and helps keep down indoor air temperatures. If glazing is well shaded to keep out direct sunlight, the mass can substantially reduce or eliminate completely the need for mechanical cooling.

The standards specify thermal mass materials as including, but not limited to:

- Hard-surfaced slab floors
- Masonry walls and fireplaces
- Gypsum board walls and ceilings in excess of 1/2 inch thickness

The physical properties of thermal mass materials are listed in Table G-12.

Table G-13 lists recommendations on when it is appropriate to take credit for a particular mass material. The intent of these guidelines is to prevent taking thermal mass credit for floor materials that are likely to be covered with carpeting at the time of building occupancy.

Building officials should allow flexibility for building designs that include radiant floor heating systems and/or that incorporate large areas of uncarpeted slabs in conjunction with south facing glazing as an integral component of deliberately designed passive solar structures.

Thermostatic Expansion Valves (TXV)

A thermostatic expansion valves (TXV) is a metering device for refrigerant flow into the evaporator of an air conditioner or heat pump. Refrigerant flow is metered in response to the temperature of the refrigerant leaving the evaporator. A TXV improves efficiency and mitigates the effect a system with improper refrigerant charge. The valve is placed upstream from the evaporator inlet and is connected to a temperature sensing bulb and pressure tap that are located at the evaporator outlet. As the gaseous refrigerant leaves the evaporator the TXV senses its temperature and pressure (superheat) and adjusts the flow rate to maintain the super heat at a constant value. Eligible systems must provide a removable door or other method of access for verifying the valve is installed and must include verification by a HERS rater. Package D requires either a TXV or testing of refrigerant charge and airflow in climate zones 2 and 8 through 15.

*Figure G-10:
Thermostatic
Expansion Valve*



Title 24

The *State Building Code*, published in Title 24 of the *California Code of Regulations*. The *Energy Efficiency Standards* are contained in Part 6. Part 1 includes the administrative requirements of the standards.

Table G-14:
Standard U-factors
of Wood Frame
Roofs and
Ceilings¹

Ceiling Insulation	Framing Spacing	Reference Name ²	U-factor
R-0 ³	16" o.c.	R.0.2X6.16	0.297
R-0 ³	24" o.c.	R.0.2X4.244	0.305
R-11 ³	16" o.c.	R.11.2X6.16	0.076
R-11 ³	24" o.c.	R.11.2X4.24	0.076
R-13 ³	16" o.c.	R.13.2X6.16	0.069
R-13 ³	24" o.c.	R.13.2X4.24	0.069
R-19	16" o.c.	R.19.2X8.16	0.051
R-19	24" o.c.	R.19.2X4.24	0.047
R-22	16" o.c.	R.22.2X10.16	0.044
R-22	24" o.c.	R.22.2X4.24	0.041
R-30	16" o.c.	R.30.2X10.16	0.036
R-30	16" o.c.	R.30.2X12.16	0.035
R-30	24" o.c.	R.30.2X4.24	0.031
R-38	16" o.c.	R.38.2X12.16	0.030
R-38	16" o.c.	R.38.2X14.16	0.028
R-38	24" o.c.	R.38.2X4.24	0.025
R-49	16" o.c.	R.49.2X4.16	0.019
R-49	24" o.c.	R.49.2X4.24	0.019

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 ASHRAE Handbook of Fundamentals.

2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.

3. Does not meet the minimum level required as a mandatory measure (see Chapter 2).

4. Roof/ceiling assemblies whose reference names list 2X4 framing include an attic space.

U-factor

The U-factor is the "overall coefficient of thermal transmittance of a construction assembly, in Btu/(hr x ft² x °F), including air film resistances at both surfaces." [§101]

The standard U-factors listed in Tables G-14 through G-17 must be used for wood frame assemblies unless a Form 3R is completed as explained under R-value. Appendix H contains completed Form 3Rs for each standard assembly. If insulation level and framing material are known, but no other information is available on the assembly, use the worst case (highest) standard U-factor for the insulation level. For wall and roof/ceiling assemblies, this corresponds to framing at 16 inch o.c.

Table G-15:
Standard U-factors
of Wood Frame
Walls¹

<i>Wall Insulation</i>	<i>Framing Spacing</i>	<i>Reference Name²</i>	<i>U-factor</i>
R-0 ³	16" o.c.	W.0.2X4.16	0.386
R-0 ³	24" o.c.	W.0.2X4.24	0.392
R-7 ³	16" o.c.	W.7.2X4.16	0.130
R-7 ³	24" o.c.	W.7.2X4.24	0.127
R-11 ³	16" o.c.	W.11.2X4.16	0.098
R-11 ³	24" o.c.	W.11.2X4.24	0.094
R-13	16" o.c.	W.13.2X4.16	0.088
R-13	24" o.c.	W.13.2X4.24	0.085
R-15	16" o.c.	W.15.2X4.16	0.081
R-15	24" o.c.	W.15.2X4.24	0.077
R-19	16" o.c.	W.19.2X6.16	0.065
R-19	24" o.c.	W.19.2X6.24	0.063
R-21	16" o.c.	W.21.2X6.16	0.059
R-21	24" o.c.	W.21.2X6.24	0.056
R-25	16" o.c.	W.25.2X6.16	0.046
R-29	16" o.c.	W.29.2X4.16	0.035
Solid core wood door (no insulation)		D.O.SCW	0.330

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 ASHRAE Handbook of Fundamentals.
2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2).

NOTE:

Table G-18 lists standard U-factors for steel frame walls. These values must be used in compliance calculation unless the U-factor of the proposed steel frame wall assembly is determined using the methods indicated in Appendix I.

To determine if an assembly meets the minimum insulation levels required by the mandatory measures or the prescriptive packages, complete a Form 3R (for wood frame assemblies) and see if the proposed U-factor is less than or equal to the standard U-factor for that assembly type and insulation level as listed in Tables G-14 through G-17. Match the standard U-factors listed for framing spacing of 16" o.c. for walls and roofs/ceilings.

Table G-16:
Standard U-factors
of Wood Frame
Raised Floors¹

Floor Insulation	Spacing	Reference Name²	U-factor
R-0 ³	No C.S. ⁴	FXO.2X6.16	0.238
R-0 ³	With C.S. ⁴	FC0.2X6.16	0.097
R-11 ³	No C.S.	FX11.2X6.16	0.071
R-11 ³	With C.S.	FC11.2X6.16	0.049
R-13	No C.S.	FX13.2X6.16	0.064
R-13	With C.S.	FC13.2X6.16	0.046
R-19	No C.S.	FX19.2X8.16	0.048
R-19	With C.S.	FC19.2X8.16	0.037
R-21	No C.S.	FX21.2X8.16	0.045
R-21	With C.S.	FC21.2X8.16	0.035
R-30	No C.S.	FX30.2X10.16	0.034
R-30	With C.S.	FC30.2X10.16	0.028

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 ASHRAE Handbook of Fundamentals.

2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.

3. Does not meet the minimum level required as a mandatory measure (see Chapter 2).

4. No C.S. = No Crawl Space, With C.S. = With Crawl Space

Fenestration U-factors measure the thermal transmittance of the entire fenestration product, including the glazing, framing and any dividers. Default fenestration U-factors are listed in Table G-4. See also *Fenestration Product*, *Insulation R-Value* and *R-Value*.

Table G-17:
Standard U-factors
of Wood Foam
Panel
Roofs/Ceilings and
Walls¹

Roof/Ceiling Insulation	Framing Spacing	Reference Name²	U-factor
R-14 ³	48" o.c.	RP.14.2X4.48	0.064
R-22	48" o.c.	RP.22.2X6.48	0.044
R-28	48" o.c.	RP.28.2X8.48	0.035
R-35	48" o.c.	RP.35.2X10.48	0.029

Wall Insulation	Framing Spacing	Reference Name	U-factor
R-14	48" o.c.	WP.14.2X4.48	0.071
R-22	48" o.c.	WP.22.2X6.48	0.049

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 ASHRAE Handbook of Fundamentals.

2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.

3. Does not meet the minimum level required as a mandatory measure (see Chapter 2).

Unconditioned Space

"Unconditioned space is enclosed space within a building that is not conditioned space. . ." [§101]

A space is unconditioned if:

- It is not provided with space conditioning;
- It can be isolated from conditioned space by closeable doors; and
- It is not indirectly conditioned.

Common unconditioned spaces include garages, attics, crawl spaces, mechanical closets and sunspaces. Refer to Chapter 5 for further information concerning modeling unconditioned spaces using approved computer methods.

Table G-18: U-factors of Steel Frame Walls¹

Wall Insulation	Framing Type	Framing Spacing	Reference Name²	U-factor³
R-11 ³	2x4	16" o.c.	W.11.S2X4.16	0.202
R-11 ³	2x4	24" o.c.	W.11.S2X4.24	0.173
R-13 ³	2x4	16" o.c.	W.13.S2X4.16	0.195
R-13 ³	2x4	24" o.c.	W.13.S2X4.24	0.165
R-15 ³	2x4	16" o.c.	W.15.S2X4.16	0.189
R-15 ³	2x4	24" o.c.	W.15.S2X4.24	0.158
R-19 ³	2x6	16" o.c.	W.19.S2X6.16	0.162
R-19 ³	2x6	24" o.c.	W.19.S2X6.24	0.135
R-21 ³	2x6	16" o.c.	W.21.S2X6.16	0.157
R-21 ³	2x6	24" o.c.	W.21.S2X6.24	0.130
R-22 ³	2x6	16" o.c.	W.21.S2X6.16	0.158
R-22 ³	2x6	24" o.c.	W.21.S2X6.24	0.132

1. Based on ASHRAE Zone Method Calculation, 1993 ASHRAE Handbook of Fundamentals.

2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.

3. Does not meet the minimum level required as a mandatory measure (see Chapter 2).

Unit Interior Mass Capacity (UIMC)

Unit Interior Mass Capacity (UIMC) is the "amount of effective heat capacity per unit of thermal mass, taking into account the type of mass material, thickness, specific heat, density and surface area." [§101]

See *Thermal Mass*.

Vapor Barrier

A vapor barrier is "a material with a permeance of one perm or less which provides resistance to the transmission of water vapor." [§101] Vapor barriers are mandatory in Climate Zones 14 and 16 only.

A vapor barrier is a special covering over framing and insulation that provides extra protection to the insulation from moisture condensation that could destroy it. Vapor barriers are installed on walls only, unless the building has an unvented attic in which case a vapor barrier would also be installed on the ceiling.

A perm is defined as equal to 1 grain of water vapor transmitted per 1 square foot per hour per inch of mercury pressure difference.

See Chapter 2 for installation information and material specifications. See also *Infiltration Controls*.

Ventilation Air

"Ventilation air is that portion of supply air which comes from outside plus any recirculated air that has been treated to maintain the desired quality of air within a designated space." [This definition is extracted from the historical 1988 Energy Efficiency Standards § 101] Also see Chapter 4 for compliance using mechanical ventilation.

Weatherstripping

Specially designed strips, seals and gaskets attached to doors and windows to prevent infiltration and exfiltration through cracks around the openings. Weatherstripping is one of the mandatory requirements for all new residential construction. See *Infiltration*, *Exfiltration*, also Chapter 2.

Weighted Averaging

Whenever two or more types of a building feature, material or construction assembly occur in a building, a weighted average of the different types must be calculated.

Weighted averaging is simply a mathematical technique for combining different amounts of various components into a single number. Weighted averaging is frequently done when there is more than one level of floor, wall, or ceiling insulation in a building, or more than one type of shading device on windows.

Area-weighted R-values are never used; only area weighted U-factors.

The formula for weighted averaging (WA) is:

$$\text{Area Weighted Average} = \frac{\text{Area}_1 \times \text{Value}_1 + \text{Area}_2 \times \text{Value}_2 + \text{Area}_3 \times \text{Value}_3 + \dots + \text{Area}_n \times \text{Value}_n}{\text{Total Area}}$$

"Area" can be replaced throughout the formula by "Length" or any other unit of measure used for the value being averaged. "Value" can be replaced throughout the formula by "U-factor," "Solar Heat Gain Coefficient," or any other value which varies throughout a residence and is appropriate to weight average.

NOTE:

It is incorrect to area-weight different R-values. Only U-factors can be area-weighted as explained in the Glossary discussion of R-Value.

West-Facing

"West-facing is oriented to within 45 degrees of true west, including 45°0'0" due north of west (NW) but excluding 45°0'0" south of west (SW)." [§101]

This definition applies only to the prescriptive packages, and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.

The designation "West-Facing" is also used in production buildings using orientation restrictions (e.g., Shaded Areas: West-Facing). See Chapter 8.

Wood Heater

See Chapter 8.

Zonal Control

Zonal control refers to the practice of dividing a residence into separately controlled HVAC zones. This may be done by installing multiple HVAC systems that condition a specific part of the building, or by installing one HVAC system with a specially designed distribution system that permits zonal control.

The Energy Commission has approved an exceptional method for analyzing the energy impact of zonally controlled space heating and cooling systems. See Chapter 8 for a complete explanation of all the criteria.

See also *Zone*.

*Zone, Space
Conditioning*

A space conditioning zone is "a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in ... 150(h) ... can be maintained throughout the zone by a single controlling device." [§101]